REPORT

Ecological Screening of the Proposed South Witbank Pipeline

Glencore Operations South Africa (Pty) Ltd

Submitted to:

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2015

Submitted by:

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Details of the specialist

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Declaration of Independence by Specialist

I, Andrew Zinn declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the proposed South Witbank Pipeline Project;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed;
- Do not have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity; and
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

APPENDIX 6 OF THE EIA REGULATIONS

Where applicable, this baseline report has been written in compliance with Appendix 6 of the EIA Regulations.

Section	Requirements	Section addressed in report
1.(1)	A specialist report prepared in terms of these Regulations must contain	
(a)	Details of	
(i)	the specialist who prepared the report; and	See preceding page
(ii)	the expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix C
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority	See preceding page
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.0
(cA)	an indication of the quality and age of base data used for the specialist report;	Sections 3.1.1, 3.1.2
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6.4
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Sections 3.1.2
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3.0
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Figure 1 Section 6.0
(g)	an identification of any areas to be avoided, including buffers;	Section 7.0, Figure 3
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 3
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 3.5 Appendix B

Section	Requirements	Section addressed in report
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity **(including identified alternatives on the environment)** or activities;	Section 6.0
(k)	any mitigation measures for inclusion in the EMPr;	Section 7.0
(l)	any conditions for inclusion in the environmental authorisation;	Section 8.0
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	
(n)	a reasoned opinion—	
(i)	**(as to)** whether the proposed activity, activities or portions thereof should be authorised;	Section 7.0 Section 8.0
(iA)	regarding the acceptability of the proposed activity or activities; and	
(ii)	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	**n/a**
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	
(q)	any other information requested by the competent authority.	n/a
2.	Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	n/a

1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd (Golder) has been appointed by Glencore Operations South Africa (Pty) Ltd. (GOSA) to conduct a terrestrial ecology screening study for the proposed development of a pipeline for the conveyance of excess mine affected water from Goedgevonden Colliery (GGV) Joint Venture (JV) to the underground workings at South Witbank Colliery (SWC) (now Tweefontein South), in Mpumalanga Province, South Africa.

This document presents the terrestrial ecology baseline situation within the pipeline footprint, and the results of the assessment of the impacts associated with the construction and the operation of the pipeline.

2.0 LOCATION OF THE STUDY AREA

The proposed pipeline will convey excess mine affected water from GGV to South Witbank Colliery (SWC) (Tweefontein South). Three pipeline route alternatives are under investigation (route 1, route 2 and route 3) (shown in Figure 1). Each alternative is essentially a variation / extension of a central route, which is largely aligned to an existing gravel road that runs on a north-south axis, to the south of the GGV tailings storage facility (TSF). The most northerly portion of the common route is also aligned to an existing rail loop that circumvents the TSF (Figure 2).

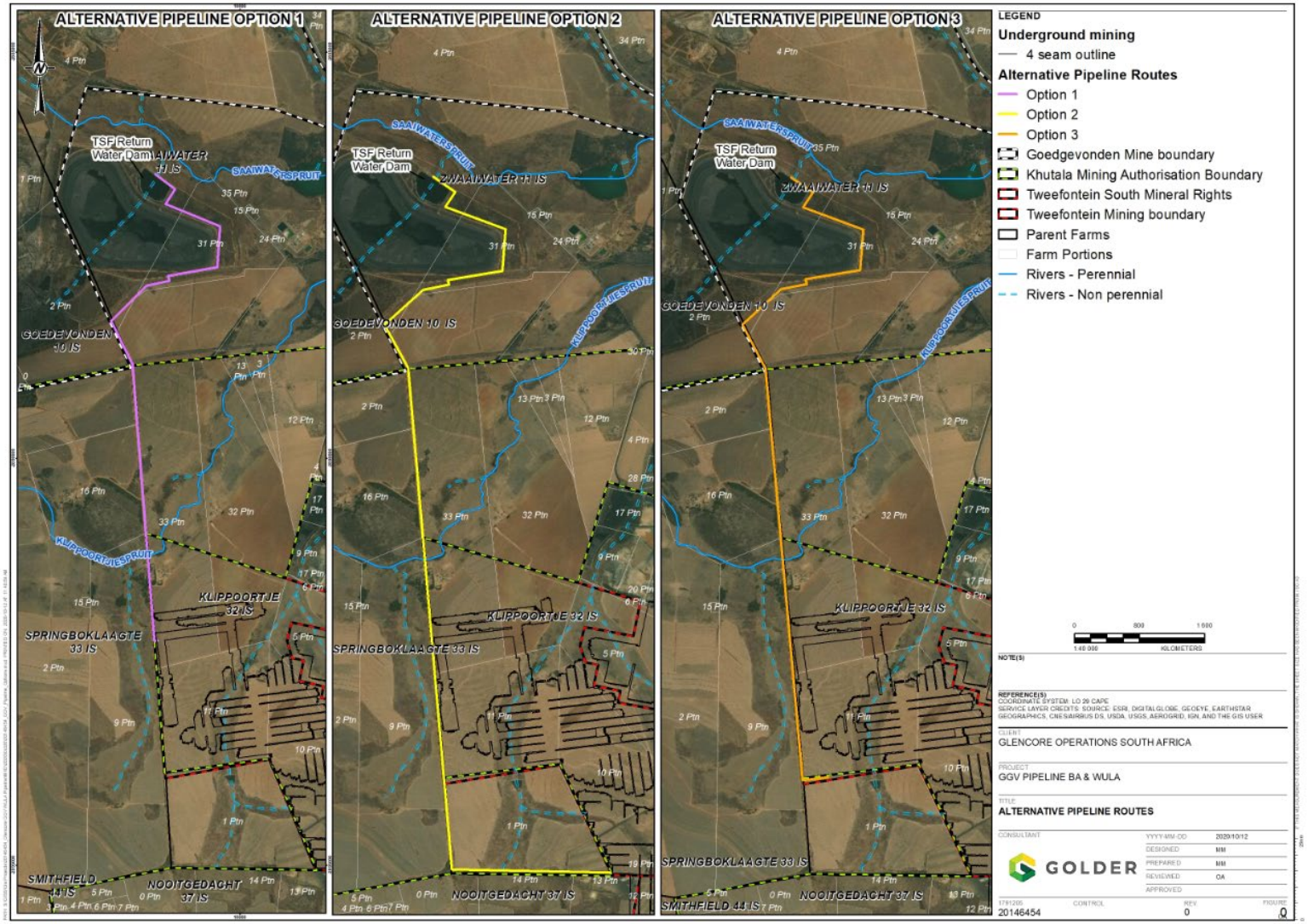

Figure 1: Location of the three proposed pipeline route alternatives

3.0 STUDY APPROACH AND METHODOLOGY

The terrestrial ecology screening study included a desktop literature review followed by a field programme, which comprised a site investigation of the proposed pipeline route alternatives. Tasks associated with these are discussed below:

3.1 Literature Review

- A general vegetation type description relevant to the broader study area was obtained from Mucina and Rutherford (2006);
- The formal conservation context of the region at a provincial and national level was established based on the Mpumalanga Biodiversity Sector Plan (2013) and the National List of Threatened Ecosystems (NEMBA Threatened Ecosystems, 2011);
- A preliminary review of land cover and possible habitat types was undertaken at a desktop level using available satellite imagery;
- A list of flora species likely to occur in the area were obtained from the SANBI[1] online Botanical Database of Southern Africa (BODATSA, 2016); and
- Lists of potential fauna species of conservation concern that may occur along the pipeline route were obtained from existing specialist studies, guidebooks and on-line databases including *inter alia*, SABAP2, Stuart and Stuart (2007), Bates, et al. (2014), and Du Preez and Caruthers (2009).

3.2 Field Programme

The field programme aimed to ground-truth the general ecological character of the corridor (footprint) associated with each pipeline route alternative. A one-day screening site visit was conducted on the 16th July 2020, during which the following data was collected at select points along the pipeline route alternatives:

- General habitat character, i.e. habitat type and structure, landscape context, and evidence of disturbances;
- Flora species composition and habitat integrity; and
- Appraisal of habitat suitability for fauna.

Representative photographs were also collected.

3.3 Screening of Flora and Fauna Species

3.3.1 Threatened and Protected Species

The Red List and protected status of floral and faunal species occurring or potential occurring in the study area was based on:

- Regional/National Red List Status, as per:
  - Red List of South African Plants Version (SANBI, 2017);
  - Red List of Mammals of South Africa, Lesotho and Swaziland (EWT, 2016);
  - Regional Red List for Birds of South Africa, Lesotho and Swaziland (BirdLife South Africa, 2015);

[1] South African National Biodiversity Institute

  - Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland (Bates et al., 2014); and
  - International Union for the Conservation of Nature (IUCN) Rd List of Threatened Species (for amphibians).
- National Environmental Management: Biodiversity Act (NEMBA) (Act No. 10 of 2004) - Threatened or Protected Species List (2007); and
- Mpumalanga Nature Conservation Act (No. 10 of 1998).

3.3.2 Alien Invasive Species

Alien invasive plant species recorded on site were categorised according to the listings in the following legislation:

- Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983); and/or
- National Environmental Management: Biodiversity Act (NEMBA) (Act No. 10 of 2004) - 2016 listing.

3.4 Fauna Habitat Suitability Assessment

The *probability of occurrence*' for each fauna species of conservation concern potentially occurring in the study area was determined by assessing habitat suitability. Using aerial imagery and general observations made during the field survey, the following parameters were used to guide the assessment of habitat suitability:

- **Habitat requirements:** Most threatened and endemic species have very specific habitat requirements. The presence of these habitats in the study area was evaluated;
- **Habitat status:** The status or ecological condition of available habitat in the area was assessed. Often a high level of habitat degradation will negate the potential presence of sensitive species; and
- **Habitat linkage:** Dispersal and movement between natural areas for breeding and feeding are important population-level processes. Habitat connectivity within the study area and to surrounding natural habitat and corridors was evaluated to determine the likely persistence of species of concern in the study area.

Probability of occurrence is presented in three categories, namely:

- **Recorded**: The species was observed on-site during the field programme;
- **High**: The species is likely to occur on the site due to suitable habitat and resources being present on or nearby the site;
- **Moderate**: The species may occasionally occur on the site, or move through the site (in the case of mobile species), due to potential habitat and/or resources; or
- **Low**: The species will not likely occur on the site due to lack of suitable habitat and resources.

3.5 Assumptions and Limitations

The faunal assessment is qualitative in nature, given the difficulty in fully sampling and characterising the abundance and distribution of faunal species in the Study Area during the snap-shot period of time allocated to baseline studies. However the available secondary data derived from literature review and desktop study, in combination with the experience of the ecology team, has nevertheless enabled a robust assessment of the potential impacts of the pipeline project to be made.

4.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The following national and provincial legislation was consulted:

- National Environmental Management Act (Act No. 107 of 1998) (NEMA);
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA), specifically:
  - ToPS – National lists of critically endangered, endangered, vulnerable and protected species (2007;
  - National list of threatened terrestrial ecosystems for South Africa (2011) (NEMBA Threatened Ecosystems, 2011);
  - National list of alien and invasive species (2016);
- Environment Conservation Act (Act No. 73 of 1989), specifically the Lists of declared weeds and invader plants (CARA, 1983);
- National Water Act (Act No. 36 of 1998); and
- Mpumalanga Nature Conservation Act (Act No. 10 of 1998).

5.0 ECOLOGICAL BASELINE CHARACTERISATION

5.1 Regional Ecological Setting

The project site falls within the Mesic Highveld Grassland Bioregion that forms part of the Grassland Biome of South Africa. The dominant vegetation type found in this bioregion is Eastern Highveld Grassland (Mucina and Rutherford, 2006). A brief description of this vegetation type is provided below, with the regional delineation shown in Figure 2.

Vegetation and Landscape Features

Eastern Highveld Grassland occurs on slightly-to moderately undulating plains, including some low hills and pan depressions. The vegetation is short dense grassland dominated by the typical Highveld grassland species (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya* etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Senegalia caffra, Celtis africana, Diospyros lycioides* subsp *lycioides, Parinari capensis, Protea caffra, P. welwitschii* and *Rhus magalismontanum*) (Mucina and Rutherford, 2006).

Important Plant Taxa

Mucina and Rutherford (2006) recognised the following species as important taxa[2] in Eastern Highveld Grassland:

Graminoids: *Aristida aequiglumis, A. congesta, A. junciformis* subsp. *galpinii, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, D. tricholaenoides, Elionurus muticus, Eragrostis chloromelas, E. curvula, E. plana, E. racemosa, E. sclerantha, Heteropogon contortus, Loudetia simplex, Microchloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, S. pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, T. rehmannii, Alloteropsis semialata* subsp. *eckloniana, Andropogon appendiculatus, A. schirensis, Bewsia biflora, Ctenium concinnum, Diheteropogon amplectens, Eragrostis capensis, E. gummiflua, E. patentissima, Harpochloa falx, Panicum natalense, Rendlia altera, Schizachyrium sanguineum, Setaria nigrirostris* and *Urelytrum agropyroides.*

Herbs: *Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides, Pelargonium luridum, Acalypha angustata, Chamaecrista mimosoides, Dicoma anomala, Euryops gilfillanii, E. transvaalensis subsp. setilobus, Helichrysum aureonitens, H. caespititium, H. callicomum, H. oreophilum, H. rugulosum, Ipomoea crassipes,*

[2] Important plant taxa are those species that have a high abundance, a frequent occurrence (not being particularly abundant) or are prominent in the landscape within a particular vegetation type (Mucina and Rutherford, 2006)

Pentanisia prunelloides subsp. latifolia, Selago densiflora, Senecio coronatus, Vernonia oligocephala and *Wahlenbergia undulata.*

Geophytic Herbs: *Gladiolus crassifolius, Haemanthus humilis subsp. hirsutus, Hypoxis rigidula* var. *pilosissima* and *Ledebouria ovatifolia.*

Succulent Herb: *Aloe ecklonis.*

Low Shrubs: *Anthospermum rigidum* subsp. *pumilum* and *Seriphium plumosa.*

5.2 Local Drainage Systems

The Klippoortjiespruit River is an important drainage feature in landscape. It flows in a northeast direction and bisects the three proposed route alternatives. To the northeast of the study area, it joins the Saaiwaterspruit, and the Tweefonteinspruit before following into Witbank Dam, which is located to the south of the town of eMalahleni.

5.3 National and Provincial Conservation Context

At a national level, the Eastern Highveld Grassland vegetation type, in which the proposed pipeline route alternatives are located, is listed as a Vulnerable ecosystem-type. Vulnerable ecosystems are considered at high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems.

According to the Mpumalanga Biodiversity Sector Plan (MBSP) (2013), none of the three proposed pipeline route alternatives traverses land designated as ‘CBA Irreplaceable’ or ‘CBA Optimal’. A patch of ‘CBA Irreplaceable’ land is located immediately to the north of where the common route begins at the TSF RWD (Figure 3). All three routes cross the Klippoortjiespruit River, which is designated as ‘Other Natural Areas’, while Route 2 traverses additional patches of land with this designation (shown Figure 3).

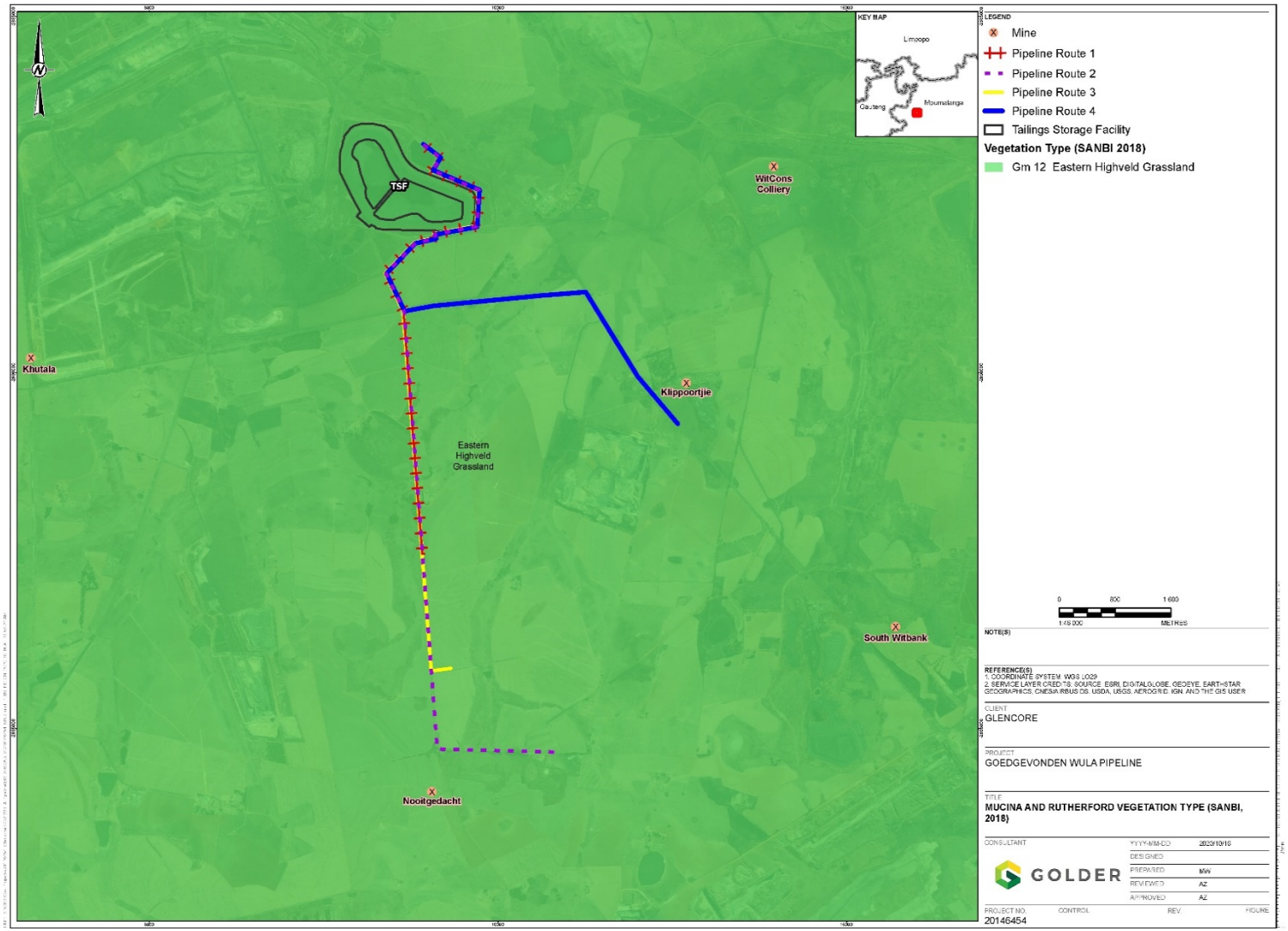

Figure 2: Pipeline route in relation to Mucina and Rutherford's (2006) regional vegetation types

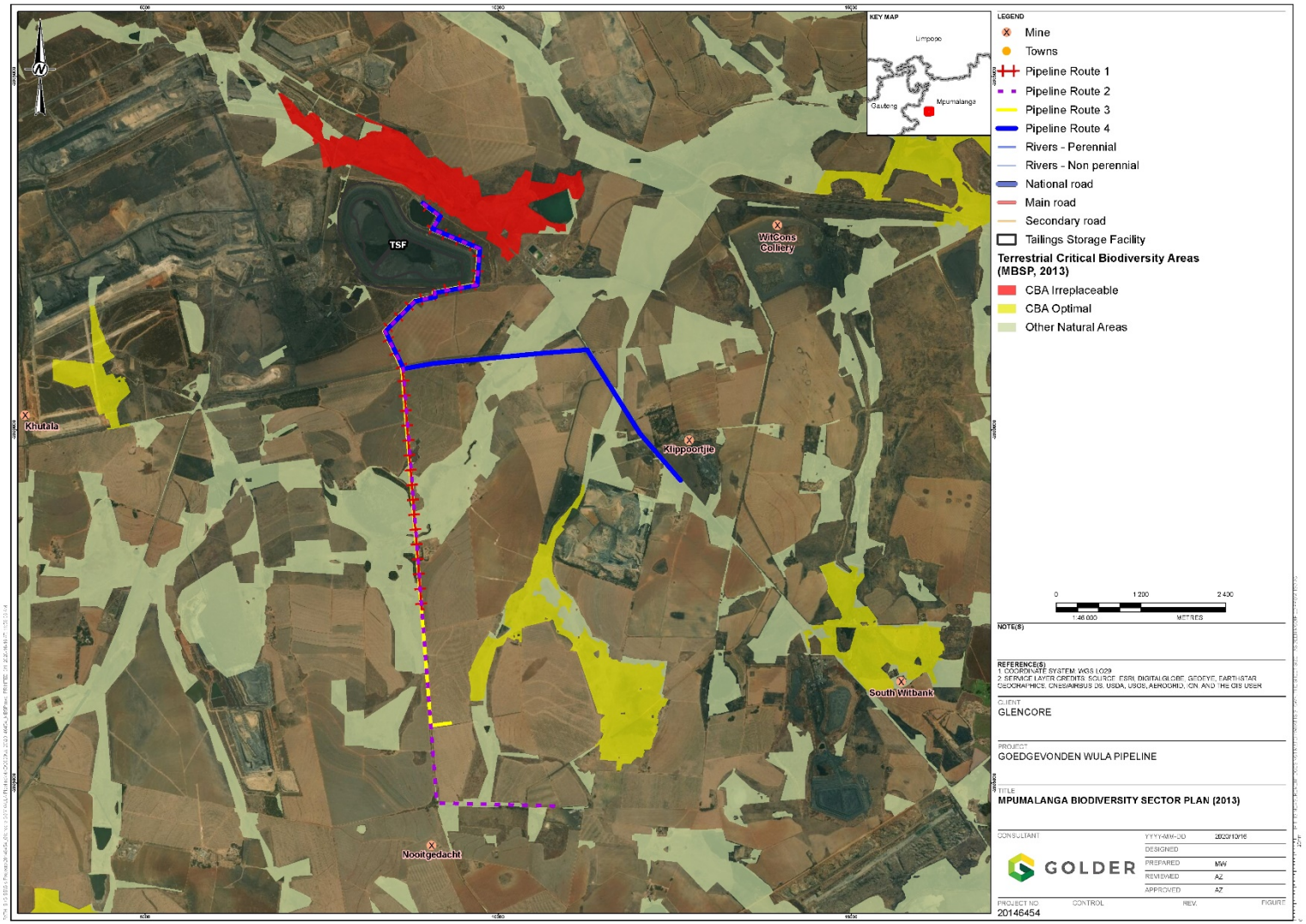

Figure 3: Pipeline route in relation to the MBSP (2013)

5.4 Vegetation and Flora Assessment

The field visit focused on the likely development and disturbance footprints of the proposed pipeline route alternatives. The majority of the length of each pipeline route is aligned to existing gravel road(s). The northern portion of the common route which begins at the TSF RWD is also aligned with rail infrastructure. Lands within the road and rail servitudes is typically either transformed or characterised by disturbed, secondary habitat types. Habitat units observed within the Study Area are described, with accompanying photographs, in the following sections.

5.4.1 Transformed Land

Large portions of each proposed route alternative are aligned with cultivated fields. At the time of the field visit, these areas had recently been ploughed/turned and were thus completely transformed, with little-to no vegetation present (Figure 4). In the absence of additional perturbation, these areas will be rapidly colonised by weedy, pioneer herbaceous species. They are thus of negligible ecological integrity and conservation importance.

5.4.2 Dry Secondary Grassland

Dry secondary grassland characterises the road reserves and much of the remaining areas of each proposed route alternative. These grasslands have been subject to historic disturbance, and are typically dominated by hardy ruderal grasses and various weed species (Figure 4 to Figure 6).

The tall thatching grass *Hyparrhenia hirta* is the most dominant species in dry areas of secondary grassland, while other commonly recorded grasses include *Chloris gayana*, *Cynodon dactylon, Digitaria eriantha, Eragrostis chloromelas, E. racemosa, Melinis repens* and *Pogonarthria squarrosa*. Various alien weed herbaceous are abundant in these habitats and include, *Amaranthus* sp., *Bidens pilosa, Cosmos bipinnatus, Datura ferox, D. stramonium, Gomphocarpus fruticosus, Pseudognaphalium luteo-album, Tagetes minuta, Verbena bonariensis* and *Xanthium strumarium.* Many of these are listed as declared alien invasive species – refer to Section 3.3.2.

Woody species are not abundant in most areas of disturbed secondary grassland, although stands of alien Wattle trees (*Acacia mearnsii* and *A. dealbata*) are present at certain locations - refer to 5.4.4. Woody species that were recorded as scattered individuals in this habitat unit include *Celtis africana, Lopholaena coriifolia*, *Prunus persica* and *Seriphium plumosa.*

Figure 4: Transformed land - recently turned earth within the road reserve, adjacent to a fallow agricultural field

Figure 5: Common route as it enters the GGV mining area. Note highly disturbed habitat, dominated by the weeds *Bidens pilosa* and *Tagetes minuta*

Figure 6: Typical dry secondary grassland in the road reserve of all three route alternatives. *Hyparrhenia hirta*, *inter alia*, is a dominant species growing within the road reserve

5.4.3 Moist Grassland

Small areas of moist grassland associated with drainage features including modified drainage trenches and natural river/wetland systems (such as the Klippoortjiespruit River), occur along each proposed route alternatives (Figure 9). Moist habitats are generally grass-dominated and are composed of many common wetland species. *Imperata cylindrica* is abundant, along with *Agrostis lachnantha, Andropogon eucomus, Andropogon huilensis, Cynodon dactylon, Eragrostis gummiflua, E. plana, Paspalum urvillei* and *Setaria pallide-fusca*. Other wetland species recorded include the tall reed, *Phragmites australis*, as well as *Juncus effusus, Typha capensis* and various *Cyperaceae*.

As areas of moist grassland are typically associated with river and wetland systems, they form important corridors linking natural habitat patches across the local landscape.

Figure 7: Area of moist grassland occurring within road reserve

Figure 8: Wetland habitat adjacent to the proposed pipeline route 2

Figure 9: Proposed pipeline crossing point over the Klippoortjiespruit

5.4.4 Alien Tree Stands

Stands of alien invasive trees are common along the three proposed pipeline route alternatives. These include well-established *Eucalyptus* windrows characterised by large, mature trees (Figure 10 and Figure 11), as well as dense thickets that are dominated by the highly invasive *Acacia dealbata* and *A. mearnsii* (wattle thickets). These thickets consist mostly of small- to medium-sized sapling and small trees (Figure 12).

Undergrowth vegetation in both the *Eucalyptus* windrows and wattle thickets is characteristically entirely denuded or sparse and dominated by herbaceous weed species, with *Bidens pilosa* and *Tagetes minuta* the most prevalent.

Alien tree stands are considered a modified habitat unit. However, within the context of the surrounding landscape, which is highly transformed and fragmented, these wooded areas do increase overall landscape heterogeneity and provide refuge habitat for various fauna.

Figure 10: *Eucalyptus* windrow lining the gravel road along which the proposed pipeline will be routed

Figure 11: Large *Eucalyptus* trees – note dominance of herbaceous weeds (*Tagetes minuta* and *Bidens pilosa*) in the undergrowth

Figure 12: Thicket of alien wattle trees (*Acacia mearnsii* and *A. dealbata*) have established along sections of the proposed pipeline route alternatives

5.4.5 Plants species of Conservation Concern

No plant species of conservation concern were recorded along the proposed pipeline routes. Table 1 lists plant species of conservation concern that may occur in the broader region, based on BODATSA (2016). Considering the general degree of habitat disturbance within the development footprints of each proposed route alternative, it is unlikely that any of species are present.

Table 1: Plant species of conservation concern potentially occurring in the region

Species Name	South African Red List	Mpumalanga Threatened Species	Probability of Occurrence
Anacampseros subnuda subsp. *lubbersii*	VU	VU	Unlikely
Frithia humilis	VU	Endangered	Unlikely
Gladiolus paludosus	VU	VU	Unlikely
Jamesbrittenia macrantha	NT	NT	Unlikely

Species Name	South African Red List	Mpumalanga Threatened Species	Probability of Occurrence
Khadia alticola	Rare	Rare	Unlikely
Khadia carolinensis	VU	VU	Unlikely
Miraglossum davyi	VU	VU	Unlikely
Streptocarpus denticulatus	VU	VU	Unlikely

5.4.6 Plants of Medicinal Value

Four plant species recorded during the field visit have recognised medicinal value. These are listed in Table 2, accompanied by a description of their purported use, as per Van Wyk et al., (2009).

Table 2: Plants with medicinal value recorded during the site visit

Scientific Name	Growth Form
Datura stramonium and D. ferox	Relieves asthma and acts to reduce pain. Weak infusions are used as an aphrodisiac.
Gomphocarpus fruticosus	Dried leaves are used to treat headaches and tuberculosis. The roots are purported to treat stomach pain and general body ache.
Typha capensis	Decoctions used to treat venereal disease, as well as diarrhoea, dysentery and enhance male libido.
Source: Medicinal uses, as per Van Wyk et al., (2009).	

5.4.7 CARA and NEMBA Listed Alien Invasive Species

Eleven plant species recorded along the proposed pipeline routes during the field visit are declared alien invasive species (Table 3); all 11 are categorised under the NEMBA (2016) and 10 under the CARA (1983).

Table 3: CARA and NEMBA listed alien invasive flora species recorded during the field visit

Scientific Name	Common Name (English)	CARA Category	NEMBA Category
Acacia dealbata	Silver wattle	2	2
Acacia mearnsii	Black wattle	2	2
Cirsium vulgare	Spear thistle	1	1b
Cortaderia selloana	Pampas grass	1	1b
Datura stramonium	Common thorn apple	1	1b
Datura ferox	Thorn apple	1	1b
Eucalyptus sp.	Gum	2	1b
Salix babylonica	Weeping willow	2	-
Solanum mauritianum	Bugweed	1	1b
Verbena bonariensis	Wild verbena	-	1b
Xanthium strumarium	Large Cocklebur	1	1b

5.5 Fauna Assessment

The majority of each route alternative is aligned to existing road and rail infrastructure, and comprises disturbed, secondary habitat. Land adjacent to each route alternative is also dominated by cultivated fields, with natural habitat confined to small, linear patches of grassland and wetland. These natural habitats will provide important movement corridors for local fauna.

Overall, considering the degree of landscape-scale habitat transformation, disturbance and fragmentation, it is considered probable that faunal abundance and diversity in the area is low. Importantly, land within and immediately adjacent to each proposed pipeline footprint is unlikely form important life-cycle habitats for fauna.

Lists of bird and mammal species of conservation concern that may occur in the region surrounding the proposed pipeline route alternatives are presented in APPENDIX A. Of these, two mammal species were determined to have a high probability of occurrence: the Cape-clawless Otter (*Aonyx capensis*) and the Serval (*Leptailurus serval*). Both species are listed as Near Threatened on the National Red List. It is expected that both species are likely to occur in areas of natural grassland and wetland habitat.

Listed reptiles that are potentially present according to the distribution maps in Bates et al (2014) include the Striped Harlequin Snake (*Homoroselaps dorsalis*) – Near Threatened (NT) and the Breyer's Long-tailed Seps (*Tetradactylus breyeri*) – Vulnerable (VU). Considering the disturbed nature of habitat, both species have a low probability of being present.

In terms of amphibians, the Giant Bullfrog (*Pyxicephalus adspersus*) is the only listed amphibian that may potentially occur in the study area. The Giant Bullfrog is listed as Protected on the NEMBA ToPS List and is listed as Vulnerable in Mpumalanga Province. The probability of this species occurring in undisturbed wetland patches adjacent to the proposed route alternatives is considered moderate.

6.0 IMPACT ASSESSMENT

6.1 Methodology

The Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, (April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as summarised on Table 4.

Table 4: Impact classification for impact assessment

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude (severity) of impact

To assess each of these factors for each impact, the ranking scales in Table 5 are used.

Table 5: Ranking scales

Probability	Duration
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8 - 15 years)
2 - Low probability	2 - Short-term (0 - 7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 - Immediate

Probability	Duration
0 - None	
Scale	**Magnitude**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

After ranking these factors for each impact, the significance of the two aspects, occurrence and severity, was assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance was then rated as per Figure 5.

Table 6: Categories describing environmental consequence

SP >75	Indicates high environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

For the methodology outlined above, the following definitions were used:

- **Magnitude** is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely-recognised standards are to be used as a measure of the level of impact;
- **Scale/Geographic** extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international;

- **Duration** refers to the length of time over which an environmental impact may occur: i.e. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent; and
- **Probability** of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

6.2 Development of Mitigation Measures

A common approach to developing mitigation measures for critical impacts is to specify a range of targets with a predetermined acceptable range and an associated monitoring and evaluation plan. To ensure successful implementation, mitigation measures should be unambiguous statements of actions and requirements that are practical to execute. The following summarise the different approaches that may be used in prescribing and designing mitigation measures:

- **Avoidance**: mitigation by not carrying out the proposed action on the specific site, but rather on a more suitable site;
- **Minimization**: mitigation by scaling down the magnitude of a development, reorienting the layout of the project or employing technology to limit the undesirable environmental impact. It also includes taking ongoing maintenance steps during the course of the action;
- **Rehabilitation**: mitigation through the rehabilitation/restoration of environments affected by the action; and
- **Compensation**: mitigation through the creation, enhancement or acquisition of similar environments to those affected by the action.

6.3 Identification and Assessment of Impacts

Several potential negative impacts on terrestrial ecology have been identified for the proposed project. These are:

- Habitat loss and disturbance;
- Soil erosion and sedimentation of aquatic features;
- Establishment and spread of alien invasive species;
- Mortality and disturbance of fauna; and
- Leaks/spills of contaminated water into the adjacent natural habitats.

Impact assessment ratings are provided in Table 7, with a summary of the findings presented below.

6.3.1 Habitat loss and disturbance

Impact Character

Habitat loss refers to the direct removal of natural habitat. In terrestrial ecosystems, this occurs primarily through the clearing of indigenous vegetation coupled with earth works. The immediate impact is the destruction of individual plants and some fauna species within the development footprint.

Impact Assessment

This impact has a definite probability, and a low magnitude. It is short-term in duration, and will occur at sites where construction activities will take place, resulting in an impact significance of Moderate prior to mitigation.

Provided that the proposed mitigation measures are implemented as part of the construction phase, the potential impact may be reduced to **Low** significance.

6.3.2 Soil erosion and sedimentation of aquatic features

Impact Character

Disturbance to existing vegetation during construction coupled with soil mobilisation from earth works, may cause erosion, which could lead to increases in sediment load adjacent aquatic/wetland systems. This may result in a reduction in aquatic ecosystem integrity of the Klippoortjiespruit.

Impact Assessment

This impact is of high magnitude and medium-term in duration. It may however, extend beyond the immediate development footprint. This results in an impact significance of Moderate prior to mitigation. Provided that the proposed mitigation measures are implemented during the construction phase, the potential impact may be reduced to **Low** significance.

6.3.3 Establishment and spread of alien invasive species

Impact Character

Disturbances caused by vegetation clearing and earth works can create conditions conducive to the establishment and rapid colonisation of alien invasive species. If left uncontrolled, alien species can spread exponentially, suppressing or replacing indigenous vegetation. This may lead to a breakdown in ecosystem functioning and a loss of biodiversity.

Impact Assessment

Although alien invasive species are currently common along the proposed pipeline routes, additional disturbances caused by construction activities will cause the further establishment and spread of invasive plants. Although initiated during the construction phase, this impact will persist throughout all phases of the proposed project unless correctly managed, and therefore has a long-term duration. It has a high magnitude and probability of occurrence, and will occur in all sites that are disturbed by construction, resulting in an impact significance of Moderate prior to mitigation. Provided that the proposed mitigation measures are implemented as part of the construction phase, the potential impact may be reduced to **Low** significance.

6.3.4 Mortality and disturbance of fauna

Impact Character

Smaller and less mobile fauna species may be trapped, injured and killed during vegetation clearing and earth works. Fauna that are of particular concern in this regard include fossorial[3] mammals (e.g. moles, rodents), nesting birds, and reptiles and amphibians. Fauna may also be disturbed by mechanical noise from construction machinery during construction phases.

Impact Assessment

This Negative impact is associated with vegetation clearing and earth works conducted during the construction phase of the project. It will be limited to the construction footprint, and will have a low probability. Impact duration will be immediate duration, but impact magnitude is considered minor. Both prior and after mitigation this potential impact will have a **Low** significance.

[3] Organism adapted to digging and life underground.

6.3.5 Leaks/spills of contaminated water into the adjacent natural habitats

Impact Character

In the event of a spill or leak, it is likely that contaminated water from the pipeline may enter into the adjacent natural habitat. This may cause a reduction in water quality and negatively impact the integrity and health of aquatic features.

Impact Assessment

This impact is Negative and of high magnitude. It is short-term in duration and may spread to the local downstream aquatic environment. This results in an impact significance of Moderate prior to mitigation. Provided that the proposed mitigation measures are implemented during operations, the potential impact may be reduced to **Low** significance.

Table 7: Impact Assessment Rating

IMPACTS ON ECOLOGY													
Impact		**Magnitude**	**Duration**	**Scale**	**Probability**	**Significance**	**Rating**	**Magnitude**	**Duration**	**Scale**	**Probability**	**Significance**	**Rating**
CONSTRUCTION PHASE		**Before Mitigation**						**After Mitigation**					
Habitat loss and disturbance		4	2	1	5	35	Moderate	2	1	1	5	20	Low
Soil erosion and sedimentation of aquatic features		8	3	2	4	52	Moderate	4	2	2	2	16	Low
Establishment and spread of alien invasive species		8	4	2	4	56	Moderate	4	2	2	2	16	Low
Mortality and disturbance of fauna		2	1	1	2	8	Low	2	1	1	1	4	Low
OPERATIONAL PHASE													
Establishment and spread of alien invasive species		8	2	2	4	48	Moderate	4	2	2	2	16	Low
Leaks/spills of contaminated water into the adjacent natural habitats		10	2	2	4	56	Moderate	6	2	2	2	20	Low
CLOSURE PHASE													
Establishment and spread of alien invasive species		8	2	2	4	48	Moderate	4	2	2	2	16	Low

6.4 Cumulative Impacts

The majority of the length of each pipeline route is aligned to existing gravel road(s), and the northern portion of the common route which begins at the TSF RWD is also aligned with rail infrastructure. Lands within the road and rail servitudes are typically either transformed or characterised by disturbed, secondary habitat types; with two crossings of wetland or riparian systems potentially occurring for each option.

The potential residual impact on these systems as a result of the proposed pipeline crossing - in terms of habitat loss and disturbance, and erosion and sedimentation in particular – is low, with the application of the recommended mitigation measures.

The effective implementation of the recommended mitigation measures, in particular, the use of appropriately designed crossing structures for wetlands/riparian areas, and the development of a construction method statement for working in wetlands/riparian areas for the pipeline crossings, will therefore be key in ensuring that landscape connectivity is maintained, impacts on wetland/riparian areas are minimised, and the Project's contribution to cumulative effects in this regard are minimised.

7.0 RECOMMENDED MITIGATION AND MANAGEMENT MEASURES

Recommended mitigation and management measures are presented in Figure 6. These measures should be considered as conditions for inclusion in the environmental authorisation.

Table 8: Recommended mitigation and management measures

Potential Impacts	Mitigation Measures	Phase
Habitat loss	***Minimisation*** ■ Vegetation clearing and earth works should be restricted to the development footprint only, with no disturbance permitted outside these areas; ■ As far as practical, vehicle access tracks and lay-down areas should be located in already disturbed areas. Where this is not possible, the disturbance footprints should also be kept to a minimum; ■ All wetlands located within the study area, but not directly crossed by the pipeline should be carefully demarcated and no construction machinery or any other vehicles should be allowed access to these areas other than along existing roads; ■ Locate all stockpiles and laydown areas at least 50 m from the edge of delineated wetlands; and ■ An Environmental Control Officer (ECO) should manage the vegetation clearing process, to ensures that vegetation sods, topsoils and subsoils from the trench excavation are stored separately, and maintained appropriately (e.g. sods should be stored under shade, and watered frequently) for later use in trench rehabilitation. ***Rehabilitation*** ■ Once the pipeline is installed, the trench should be backfilled with the subsoils first, followed by the topsoils.	Construction Phase

Potential Impacts	Mitigation Measures	Phase
	■ Any areas cleared of vegetation during construction should then be stabilised and revegetated using the sods removed at the commencement of construction activities; and ■ Bare soil areas in between the sods should be reseeded using quick-growing, indigenous grass species.	
Soil erosion and sedimentation aquatic features	***Avoidance and Minimisation*** ■ River/wetland crossing points should be constructed using engineered designs that limit flow concentration and minimise the likelihood of erosion channels being generated within the wetland by surface water discharge; and ■ Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to the crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas, and re-vegetation of disturbed areas as soon as possible. ***Rehabilitation*** ■ Once the pipeline is installed, the trench should be backfilled with the subsoils first, followed by the topsoils; ■ Any areas cleared of vegetation during construction should then be stabilised and revegetated using the sods removed at the commencement of construction activities; ■ Bare soil areas in between the sods should be reseeded using quick-growing, indigenous grass species; and ■ Sediment traps should be installed for the duration of the construction phase, should in-stream sedimentation become an issue.	Construction Phase
Establishment and spread of alien invasive species.	***Minimisation*** ■ Actively control all alien invasive species (AIS) that colonise areas that have been disturbed during the construction phase. Control should include: ▪ Annual treatments along the entire length of the pipeline and all sites disturbed during construction (e.g. vehicle access tracks and lay-down areas); ▪ A combined approach using both chemical and mechanical control methods; ▪ Periodic follow-up treatments, informed by regular monitoring; and ▪ AIS control should continue through all phases of the proposed project until such a time as monitoring indicates AIS are no longer actively establishing.	All Phases

Potential Impacts	Mitigation Measures	Phase
	Rehabilitation ■ Once the pipeline is installed, the trench should be backfilled with the subsoils first, followed by the top soils; ■ Any areas cleared of vegetation during construction should then be stabilised and revegetated using the sods removed at the commencement of construction activities; and ■ Bare soil areas in between the sods should be reseeded using quick-growing, indigenous grass species.	
Mortality and disturbance of fauna	***Avoidance and Minimisation*** ■ An ECO should be on-site during vegetation clearing to monitor and manage any wildlife-human interactions. The ECO should be trained in *inter alia*, snake handling; ■ A low speed limit (recommended 20-40 km/h) should be enforced on site to reduce wildlife-collisions; ■ The handling, poisoning and killing of on-site fauna by construction workers and contractors must be strictly prohibited; and ■ Construction contractors should be made aware of the presence of, and rules regarding, fauna through suitable induction training and on-site signage.	Construction Phase
Leaks/spills of contaminated water into the adjacent natural habitats	***Avoidance and Minimisation*** ■ Install pressure gauges to monitor water pressure differentials that may indicate pipeline leaks; ■ In the event of a leak, pipeline repairs should be conducted with alacrity; and ■ Should a leak/spill event occur into the Klippoortjiespruit River, a water quality and WET sample should be retrieved immediately upstream and downstream of the spill. This exercise should be repeated one month following the spill to compare to the initial results to ensure maintenance.	Operational Phase

8.0 DISCUSSION AND CONCLUSIONS

The majority of each proposed route alternative is aligned to existing road and rail infrastructure. Accordingly, potentially impacted land is transformed or comprises mostly disturbed, secondary habitat. Small patches of less disturbed natural grassland habitat are present adjacent to each route alternative. These are typically associated with wetland areas and the Klippoortjiespruit River. Each of the route options cross wetlands or riparian systems at two locations.

From an ecological sensitivity perspective, none of the four route options are clearly preferable to the other; although pipeline route 2 is longer and intercepts an additional area of mapped natural habitat (Figure 3), and as such, this route is least preferred.

Despite the overall disturbed nature of habitat along each proposed route alternative, it is important that measures are taken during each phase of the proposed project to limit additional disturbances that will further degrade habitat within and adjacent to the pipeline corridors. This is particularly important along portions of the selected pipeline that occur adjacent to natural habitat. In line with this, key mitigation measures that should be included in the environmental management plan for the proposed project include:

- Limiting vegetation clearing and earth works to the immediate construction footprint of the pipeline;
- Implementing erosion prevention measures, particularly at sites susceptible to erosion that occur close to drainage/wetland features;
- Stabilising and revegetating all disturbed areas after construction;
- Implementing effective measures to prevent and rapidly detect and repair any leakages from the operation pipeline that may cause environmental pollution;
- Actively controlling all declared alien invasive species occurring along the entire length of the proposed pipeline; and
- Provided that the recommended mitigation measures are strictly implemented, no significant residual impacts on habitats or species of concern are anticipated.

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APPENDIX A

Fauna species of conservation concern potentially occurring in the study area.

Table A1: Mammal species of conservation concern potentially occurring in the study area

Scientific name	Common name	Conservation Status			Probability of occurrence
		Red List (2016)	NEMBA TOPS List (2015)	Mpumalanga Protected Species (1998)	
Chrysospalax villosus	Rough-haired golden mole	Vulnerable	-	-	Moderate
Amblysomus robustus	Robust golden mole	Vulnerable	Endangered	-	Moderate
Amblysomus septentrionalis	Highveld golden mole	Near Threatened	-	-	Moderate
Miniopterus schreibersii	Schreibers' long-fingered bat	-	Protected	-	Low
Dasymys incomtus	Water rat	Near Threatened	-	-	High
Vulpes chama	Cape fox	Least Concern	Protected	-	Low
Aonyx capensis	Cape-clawless otter	Near Threatened	-	Protected	High
Leptailurus serval	Serval	Near Threatened	Protected	-	High
Mellivora capensis	Honey badger	Least Concern	-	Protected	Moderate
Ourebia ourebi	Oribi	Endangered	Endangered	Protected	Low
Raphicerus campestris	Steenbok	Least Concern	Endangered	Protected	High
Pelea capreolus	Grey rhebok	Near Threatened	-	Protected	Low
Hydrictis maculicollis	Spotted-necked otter	Vulnerable	-	Protected	Low
Felis nigripes	Black-footed cat	Vulnerable	Protected		Moderate
Atelerix frontalis	South African hedgehog	Near Threatened	-	Protected	High
Orycteropus afer	Aardvark	Least Concern	Protected	Protected	High
Redunca fulvorufula	Mountain reedbuck	Endangered	-	Protected	Moderate

Table A2: Birds species of conservation concern potentially occurring in the study area

Scientific name	Common name	Status			Probability of occurrence
		Red List (2016)	NEMBA TOPS List (2015)	Mpumalanga Protected Species (1998)	
Anthropoides paradiseus	Blue crane	Near threatened	Protected	-	Low
Eupodotis senegalensis	White-belled korhaan	Vulnerable	-	-	Low
Charadrius pallidus	Chestnut-banded plover	Near threatened	-	-	Low
Glareola nordmanni	Black-winged pratincole	Near threatened	-	-	Low
Alcedo semitorquata	Half-collared kingfisher	Near threatened	-	-	Low
Falco biarmicus	Lanner falcon	Vulnerable	-	-	Moderate
Circus ranivorus	African marsh harrier	Endangered	-	Protected	Moderate
Tyto capensis	African grass owl	Vulnerable	-	-	Moderate
Geronticus calvus	Southern bald ibis	Vulnerable	Vulnerable	-	Moderate
Phoeniconaias minor	Lesser flamingo	Near Threatened	-	-	Low
Phoenicopterus roseus	Greater flamingo	Near Threatened	-	-	Low
Sagittarius serpentarius	Secretarybird	Vulnerable	-	-	Moderate

APPENDIX B

Document limitations

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APPENDIX C

Specialist CV

Education

Master of Science (Hons) Applied Environmental Science , University College Dublin, Dublin, Ireland, 2007

Bachelor of Science (Hons) Zoology, University College Cork, Cork, Ireland, 2005

Certifications

Professional Natural Scientist (South African Council for Natural Scientific Professions) , (114477/15)

Languages

English – Fluent

French – Fluent

Golder Associates Africa (Pty.) Ltd. – Johannesburg

Biodiversity and Ecosystem Services Specialist

Aisling is an ecologist and biodiversity specialist with over 12 years consulting experience in Europe and sub-Saharan Africa. Experienced in designing, costing and conducting baseline flora and fauna surveys, ecosystem services assessments, ecological impact assessment and development of mitigation, compensation and offsetting measures for projects in the mining, O&G, waste, transport, land development and power generation sectors.

She has completed baseline biodiversity studies and ecosystem service reviews for numerous projects in Southern Africa, East Africa, and Central and West Africa, and is experienced in conducting such assessments to satisfy both national environmental regulations and international financing requirements particularly those demanded by the International Finance Corporation's 2012 Performance Standards. To date she has worked on biodiversity-related projects in Ireland, UK, Kosovo, Gabon, Guinea, Guinea-Bissau, Kenya, DRC, Mozambique and Uganda, in addition to numerous projects in South Africa, covering northern temperate, Mediterranean, tropical rainforest, desert, savanna and coastal environments.

She has specific expertise in bat survey and population assessment, having completed her MSc research on bat population correlates, carried out bat assessments for mining and wind power developments in Ireland and the UK, and conducted baseline studies of bat populations and subsequent impact assessments for both mining and power generation projects in West Africa, Central Africa, South Africa and Europe.

Employment History

Golder Associates Africa (Pty) Ltd. – Johannesburg
Terrestrial Ecologist (February 2013 to Present)

Biodiversity specialist with responsibility for Project Management and implementation of baseline biodiversity studies and impact assessments for development projects in the mining, transport, land development, power and waste sectors, in both South Africa and sub-Saharan Africa. Role responsibilities include: Project management, including budget preparation and management, task allocation, and technical review of proposals and reports; Technical review of consultant's draft reports; biodiversity study design to satisfy national legislation and international financing requirements; Biodiversity baseline and impact assessment reporting; Biodiversity offset strategies; Biodiversity action/management plans; Ecosystem services review and impact assessment; Wetland delineation surveys and assessments; Large and small mammal surveys.

Golder Associates Ireland – Naas, Ireland
Ecologist (April 2008 to Present)

Responsible for ecological input on a range of resource development, mining, power and transportation projects, both in Ireland and Internationally. Typical project activities were undertaking baseline ecological surveys including surveys

of bat activity, reptile population size and composition, newt presence/absence and population size, badger and otter presence/absence and territory size assessment, small mammal surveys, aquatic invertebrate species composition, vegetation surveys and habitat mapping. Authored numerous Ecological Baseline, Ecological Impact Assessment and Appropriate Assessment reports, in fulfilment of regulatory requirements.

Golder Associates UK – Oxford, UK
Ecologist (April 2010 to Present)

Responsible for the ecological input on a range of resource development, mining and transportation projects, both internationally and in the U.K. to inform planning applications and Ecological Impact Assessments (EcIA), and uphold monitoring regimes. Project activities included: Route options constraints study and baseline ecological survey & mapping, statutory authority consultation and stakeholder engagement for production of baseline ecology report and ecological impact assessment chapter of ESIA for Kosovo Motorway alignment; EU-protected species survey and monitoring, including great crested newts (GCN) and bat species, for several large-scale landfill and quarry sites; Reptile, amphibian, mammal and Phase 1 habitat surveys for a suite of composting/biogas developments, subsequent baseline ecology reports and Ecological Impact Assessment; Provision of Provision of Ecological clerk of works services at development sites

NATURA Environmental Consultants – Wicklow, Ireland
Ecologist (September 2007 to March 2008)

Responsible for report writing, data interpretation and analysis, and project management. Contributed extensively to the production of the publication "The Status of EU Protected Habitats and Species in Ireland" (NPWS, 2008).

University College Dublin – Dublin, Ireland
Field Assistant (July 2007 to September 2007)

Field assistant for salmonid fish population assessment and crayfish surveys, including electrofishing, fish handling and scale sampling, sorting and ID of freshwater invertebrates and plants.

Thomson Scientific & Healthcare – Limerick, Ireland
Scientific Information Specialist (May 2005 to August 2006)

Researcher responsible for writing article abstracts, proof-reading and editing newly published scientific research papers.

PROJECT EXPERIENCE – IFC PERFORMANCE STANDARD 6 PROJECTS

SMFG Nimba Fauna Baseline (2020) Nimba Mountains, Guinea	Compiled baseline fauna report for the ESIA, including update of baseline information with results of various taxonomic studies done since the original 2013 baseline, and critical habitat-triggering species descriptions.
Large Infrastructure Barging Route - Marine Ecology Impact Assessment (2020) Vilanculos, Mozambique	Lead biodiversity specialist for marine baseline surveys including sea grass and coral reef extent and condition assessments, to inform microrouting of a proposed barging route in close proximity to Bazaruto Archipelago National Park.
Konza Techno City - Biodiversity Baseline and BMP Review (2019) Machakos, Kenya	Acting as biodiversity expert on behalf of the lending institution, was responsible for review of the intial biodiversity baseline study and BMP, and development of recommendations for additonal work required to ensure that the baseline and BMP are of the standard necessary to satisfy the requirements of Performance Standard 6.
Proposed Oil Field Development (Confidential) (2014 - 2019) Turkana, Kenya	Screening for Critical Habitats as defined by IFC PS6 and IFC GN6, 2012. Desktop biodiversity description and remote land cover sensing to inform scoping report and fieldwork planning for biodiversity and ecosystem services baseline data gathering phase. Authored Biodiversity baseline report and impact assessment to Kenyan and IFC standards.
Ahafo North Mine Biodiversity Baseline and IA (2018) Brong-Ahafo, Ghana	Consolidated biodiversity data from previous studies with up-to-date baseline data on aquatic ecosystems and vegetation into an updated biodiversity baseline report and impact assessment for the proposed mining of Ahafo North
Beach Landing Sites (Confidential) - Marine and Coastal baseline and Critical Habitat Assessment (2018) Vilanculos, Mozambique	Authored marine and coastal baseline study report based on available reports and data. Determined species and ecosystem triggers of Critical Habitat in the study area and assessed impacts and developed bespoke mitigation measures to ensure NNL of natural habitat and NG of critical habitats.
Kinsevere Copper Mine (2018) Haut-Katanga, DRC	Consolidated biodiversity data from previous studies with up-to-date baseline data on flora and birds into an updated biodiveristy baseline report and impact assessment for the proposed expansion of TSF to adjoining tenement
Oil Exploration Block - Biodiversity Baseline and Impact Assessment (2018) Hoima, Uganda	Baseline biodiversity description to inform the overall Environmental Baseline Report for that exploration block. Updated biodiversity impact assessment chapter and authored cumulative impact assessment report for the project
Proposed Copper Mine (Confidential) (2017) Katanga, DRC	Ecosystem services review and impact assessment to satisfy the requirements of IFC PS6 for a proposed copper mine development.
Bokpoort Solar PV & CSP Tower (2016) Northern Cape, South Africa	Conducted specialist bat baseline study and impact assessment for solar PV and CSP tower project. Authored ecosystem services review and impact assessment for the full project.

Kingfisher Development Area (2015) Hoima, Uganda	Ecosystems goods and services assessment to IFC PS6 standards, for a proposed oil development project on the shore of Lake Albert.
Proposed Mine (Confidential) (2013) KwaZulu-Natal, South Africa	Ecosystems goods and services assessment to IFC PS6 standards, for a proposed magnetite mine in an area of tribal lands in KZN, also known for its rich biodiversity.
Proposed Iron Ore Mine (2012) Nimba, Guinea	Led specialist bat survey of proposed mine site in Guinea. Conducted extensive wet and dry season bat presence and activity surveys and established population status of a Critically Endangered bat species within proposed site. Produced Critical Habitat mapping and reporting in accordance with requirements of IFC Performance Standard 6.
Proposed Rare Earth Mine (Confidential) (2012) Gabon	Led specialist bat survey of proposed mine site in a remote rainforest area in Gabon. Conducted wet and dry season bat presence and activity surveys to get a baseline bat species list for the proposed site, which included new bat records for Gabon.

PROJECT EXPERIENCE – ECOSYSTEM SERVICES ASSESSMENT

Oil Development Block (2018) Turkana, Kenya	Ecosystem services review and impact assessment to IFC PS6 for a proposed oil field development including proposed overland haulage route.
Kingfisher Development Area (2018) Hoima, Uganda	Ecosystem services review and impact assessment to IFC PS6 standards, for a proposed oil development project on the shore of Lake Albert.
Kipoi/Luputo Mine (2016) Katanga, DRC	Ecosystem services review and impact assessment to IFC PS6 for a copper/cobalt mine in DRC.
Metalkol (2016) Kolwezi, DRC	Ecosystem services review and impact assessment to IFC PS6 for a copper/cobalt mine in DRC.
Proposed Mine, Melmoth (2015) KwaZulu-Natal, South Africa	Ecosystems goods and services assessment to IFC PS6 standards, for a proposed magnetite mine in an area of tribal lands in KZN, also known for its rich biodiversity.
Gas to Liquid Plant (2013) Tashkent, Uzbekistan	Produced ecosystem goods and services assessment based on information garnered from ecology, surface water and social baseline assessments, in order to fulfil International Finance Corporation Performance Standard 6 requirements for the project funding and ESIA.

PROJECT EXPERIENCE – BATS

Proposed Iron Ore Mine - ESIA to IFC Standards Nimba Mountains, Guinea	Led specialist bat survey of proposed mine site in Guinea. Conducted extensive wet and dry season bat presence and activity surveys and established population status of a Critically Endangered bat species within proposed site. Produced Critical Habitat mapping and reporting in accordance with requirements of IFC Performance Standard 6.
Proposed rare earth mine - ESIA to IFC Standards (Confidential), Gabon	Led a six-week specialist bat field survey of proposed mine site in a remote rainforest area in Gabon. Conducted wet and dry season bat presence and activity surveys to compile a baseline bat species list for the study area, which included new bat records for Gabon. Authored baseline and impact assessment reports to inform the overall ESIA.
Phalaborwa Mine - Artificial Roost Creation Guidance Phalaborwa, Limpopo, South Africa	Provided design guidance to our client who proposed to construct an artificial bat roost on their property using old mining vehicle tyres and overburden materials.
Kosovo Wind Farm ESIA to World Bank Standards Kosovo	Analysed passive acoustic monitoring data for bats to compile a baseline report on bat species assemblage, diversity and spatial distribution of bat activity within the wind farm area of influence.
Varkensvlei Mine ESIA Waterberg, Limpopo, South Africa	Baseline study of bat species assemblage, diversity and spatial distribution of bat activity within the surface mining rights area, including identification of sensitive habitats and terrain features on site that could constitute important roosting or foraging habitat for various species. Authored baseline and impact assessment reports to inform the overall ESIA.
Rio Tinto Tete Tete, Mozambique	Bat monitoring surveys (passive acoustic monitoring supplemented by trapping surveys) in compliance with environmental authorisation conditions and in line with the recommended mitigation measures of the ESIA.
Farim Phosphate Project ESIA Farim, Guinea-Bissau	Ecologist on Terrestrial Ecology team. Responsible for undertaking wet and dry season field survey work to establish baseline bat diversity, including passive acoustic monitoring and identification of sensitive habitats and terrain features on site that could constitute important roosting or foraging habitat for various species. Authored baseline study report to inform the ESIA.
Bokpoort Solar PV & CSP Tower (2016) Northern Cape, South Africa	Conducted specialist bat baseline surveys including passive acoustic monitoring and identification of sensitive habitats and terrain features on site that could constitute important roosting or foraging habitat for various species. Authored the baseline report and the impact assessment for a solar PV and CSP tower project, to IFC PS6 standard.

PROJECT EXPERIENCE – WETLAND ECOLOGY

AGA Pipeline wetland assessment (2019) Gauteng, South Africa	Wetland delineation, baseline PES, EIS and EcoServices scores and impact assessment for proposed water return pipeline.

Twinsaver Water Use License (2018) Gauteng, South Africa	Wetland delineation, baseline PES, EIS and EcoServices scores and impact assessment for ESIA for water use license application
Belfast Implementation Project (2015 - 2018) Mpumalanga, South Africa	Wetland baseline monitoring to inform environmental impact assessment, including multi-seasonal surveys and updates of PES, EIS and WET-Ecoservices scores for each HGM unit concerned.
Kangra Kuisipongo Overland Conveyor ESIA (2017) Kwazulu Natal, South Africa	Conducted wetland delineation and baseline assessment (PES, EIS, WetEcoservices) and impact assessment of overland coal conveyor.
Mafube LifeX Project (2015 - 2017) Mpumalanga, South Africa	Wetland mitigation strategy fieldwork and assessments. Ongoing project support during construction through monitoring and management of construction activities, and overseeing implementation of WUL conditions on the ground.
BECSA Middelburg (2015) Mpumalanga, South Africa	Wetland delineation and assessment of proposed sludge pipeline river crossings, and wetlands lying within 500m of proposed slurry dump pits to inform Water Use Licence application and EIA.
Metmar, Steelpoort (2014) Limpopo, South Africa	Delineation and assessment of floodplains of the Steelpoort River, upstream, within and downstream of the proposed site of an open cast pit.
Mooifontein, Arnot (2014) Mpumalanga, South Africa	Bird and amphibian surveys of pans and wetlands within mining rights area to update PES and EIS, for use in determining wetland reserve.
Interwaste Amadwala (2014) Gauteng, South Africa	Delineated wetlands and assessed Present Ecological Status, Ecological Importance and Sensitivity, and Ecosystem services provided by each wetland within project area of influence. Conducted impact assessment and devised mitigation measures and monitoring regimes.

PROJECT EXPERIENCE – MINING

Bankable Feasibility Study (confidential) (2019) Mpumalanga, South Africa	Responsible for authoring environment chapter of BFS.
Belfast Implementation Project (2015-2018) Mpumulanga, South Africa	Led three years of pre-construction wetland monitoring including assessment of PES, EIS and EcoServices for mining right area

Phalaborwa Mine - Biomonitoring (2015) Limpopo, South Africa	Biological monitoring of the Oliphants and Selati Rivers, including assessment of fish populations, aquatic macroinvertebrates and riparian vegetation to monitor the condition of habitat in the vicinity of the mine, observing any significant changes and providing advice to PMC on biodiversity management. This ongoing project continues to be conducted in compliance with the most rigourous health and safety standards, due to the frequent presence of dangerous large mammal fauna including elephant, buffalo and lion in and around the mine site.
Tshikondeni Mine (2014) Limpopo, South Africa	Ecologist on Terrestrial Ecology team. Responsible for undertaking wet and dry season field survey work to determine baseline large and small mammal, bat and bird diversity and vegetation community mapping for development of a rehabilitation plan for mined areas.
Bat Baseline Study to IFC Standards (2012) Gabon	Led specialist bat survey of proposed mine site in a remote rainforest area in Gabon. Conducted wet and dry season bat presence and activity surveys to get a baseline bat species list for the proposed site, which included new bat records for Gabon.
Bat Baseline Study to IFC Standards (2012) Nimba, Guinea	Led specialist bat survey of proposed mine site in an upland region of Guinea. Conducted extensive wet and dry season bat presence and activity surveys and established population status of a Critically Endangered bat species within proposed site. Produced Critical Habitat mapping and reporting in accordance with requirements of IFC Performance Standard 6.
Farim Phosphate Project ESIA (2011) Farim, Guinea Bissau	Ecologist on Terrestrial Ecology team. Responsible for undertaking wet and dry season field survey work to establish baseline bat, mammal and bird diversity, and vegetation mapping for subsequent ecological impact assessment.
Rio Tinto Tete Project (2013 - 2015) Tete, Mozambique	Ecologist on Terrestrial Ecology team. Responsible for undertaking wet and dry season field survey work to determine baseline small mammal and bird diversity and vegetation community mapping for subsequent ecological impact assessment.

PROJECT EXPERIENCE – POWER

Bokpoort CSV and PV developments (2017) Northern Cape, South Africa	Biodiversity and ecosystem serivces baseline and impact assessment as part of overall ESIA for two PV and one CSV development on adjoining properties.
Solar Park - Gordonia Park substation powerline (2016) Northern Cape, South Africa	Conducted survey of powerline route to identify cluster of protected trees, other plants of conservation importance, and areas potentially important to bird species of concern to inform the final routing and placement of pylons and bird deterrents
Kendal Power Plant (2013) Mpumalanga, South Africa	Terrestrial vegetation, bird and mammal monitoring to assess impacts of existing ash dump, and compile baseline data for proposed new ash dump.

Ndumo-Gezisa Powerline Route Corridor - Impact Assessment (2013)
KwaZulu-Natal, South Africa

Terrestrial flora and fauna assessment of route corridor options for proposed powerline approx. 30 km long. Studies included small and large mammals, birds, reptiles and vegetation mapping.

Vaalbank 88 Kv Powerline - Basic Assessment (2014)
Gauteng, South Africa

Terrestrial and wetland baseline study and impact assessment reports to assess the impacts of a proposed powerline corridor and switching station footprint.

Begg Farm Wind Cluster EIA (2012)
Fife, Scotland

Responsible for production of Environmental Impact Statement for a 3MW wind farm at Begg Farm, Kirkcaldy, Fife. Authored chapters including Project Description, Scoping, Existing Environment, Summary of Effects and Non-Technical Summary. Also responsible for authoring baseline chapter on Local Land Use and Recreational Access.

Barrel Law Wind Farm EIA (2012)
Scottish Borders, Scotland

Responsible for co-ordinating front-end production of Environmental Impact Statement for a 21MW wind farm at Barrel Law, Hawick. Authored chapters including Project Description, Scoping, Policy Framework and Existing Environment.

PROJECT EXPERIENCE – TRANSPORTATION

Kosovo Motorway ESHIA (2010)
Prizren-Pristine, Kosovo

Golder was commissioned by Bechtel/Enka to prepare Route Corridor Selection Study and Environmental and Social Impact Assessment for approx. 70 km of proposed motorway. As Project Ecologist, role included undertaking ecological constraints mapping for three route options, and multi-disciplinary walkover survey of selected route - coordinating a team of local zoological and botanical experts. Produced Ecological Impact Assessment chapter and devised design mitigation recommendations. Developed tool-box talk regarding dealing with protected species on site during construction.

PROJECT EXPERIENCE – EU HABITATS DIRECTIVE - APPROPRIATE ASSESSMENT

Report on Cumulative Impacts of Proposed Gold Mine (2010)
Krumovgrad, Bulgaria

Golder were commissioned to technically review a report outlining an Assessment of the compatibility of Natura 2000 site conservation objectives with an investment proposal for the extraction and processing of gold-bearing ore from the Krumovgrad Exploration Area. Role on this project included technical review of the report, identification of information gaps in the cumulative impact assessment, and recommendations for addressing these issues within the report.

Stage 2 Appropriate Assessment of WWTP (2011)
Kildare, Ireland

Undertook Stage 2 Appropriate Assessments of the discharges from a number of waste water treatment plants (WWTP) on Pollardstown Fen SAC, a groundwater-fed fen habitat which is the largest of its type in Ireland. WWTP that discharged to both surface water systems and groundwater systems were examined for their potential to impact on groundwater quality of the fen and subsequent impacts on the vegetation community composition of the fen, and other water-dependent protected species including the rare, EU-protected whorl snails Vertigo spp. Cumulative impact assessment reports regarding Pollardstown Fen SAC and Mouds Bog SAC were also subsequently prepared

Stage 2 Appropriate Assessment - Lidl Supermarket Extension (2011)
Tipperary, Ireland

Project Ecologist for Stage II Appropriate Assessment of proposed upgrade works to retail unit in Clonmel, Co. Tipperary, which is situated adjacent to the River Suir SAC. Role included desktop research and consultations with statutory authorities, Phase I habitat survey of lands between the retail unit and the river, Ecological Impact Assessment and subsequently Stage II Appropriate Assessment report production.

Appropriate Assessment of Quarry discharge to SAC (2011)
Carlow, Ireland

Project Ecologist responsible for undertaking an Appropriate Assessment screening of the potential impacts of a treated quarry wash-water discharge to the River Slaney, which is an SAC protected under the EU Habitats Directive. Surveys included an Extended Phase I habitat survey of the quarry site, and aquatic invertebrate sampling of the River Slaney upstream and downstream of the discharge point to assess any potential impacts of the discharge on the river water biological quality. Consultation with the regional Fisheries Board and the National Parks and Wildlife Service was undertaken and mitigation measures regarding the reduction of silt load in the discharge were recommended.

Proposed Leisure Facility Adjacent to Blessington Lake SPA
Wicklow, Ireland

Undertook Appropriate Assessment Stage 1 (Screening) and subsequent Stage 2 Appropriate Assessment of proposed leisure facility. Acquisition of additional ornithological data in consultation with local NPWS ranger and local birders in progress and final report to be submitted to NPWS for comment.

Appropriate Assessment Screening of Local Area Development Plans (2011)
Kildare, Ireland

Undertook Appropriate Assessment Stage 1 (Screening) for a number of local area plans that could potentially impact significantly on nearby protected sites including SACs and SPAs. Surveys considered features for which these sites are designed including Annex I habitats, wintering bird populations, otter, kingfisher and aquatic species such as brook lamprey.

PROJECT EXPERIENCE – UK & IRELAND: ECOLOGICAL BASELINE STUDIES AND IMPACT ASSESSMENT

Future Biogas - Various sites (2010)
Norfolk, UK

Project Ecologist responsible for undertaking Extended Phase I habitat surveys of three sites in Norfolk for which the construction of biogas plants is proposed. Each site (including a 250m buffer area surrounding the sites) was surveyed and the habitats mapped. Other features considered included hedgerow assessments, bat foraging/commuting/roosting potential assessment, and great crest newt habitat suitability assessments. During this project I was also responsible for training a third-level summer student in botanical identification and habitat mapping techniques; and desk top research and baseline data aquisition

Biffa Landfill Extension (2010)
Cambridgeshire, UK

Project Ecologist responsible for undertaking great crested newt surveys, including presence/absence, evidence of breeding, and population size, age and sex distribution enumeration.

British Sugar Site Extension (2010, 2011)
Norfolk, UK

Project Ecologist responsible for undertaking baseline ecological surveys of three large areas of arable cropland, intersected by numerous drainage ditches, where British Sugar intends to expand their processing plant. Surveys undertaken included Phase I habitat surveys, reptile surveys, and aquatic vegetation assessment and water vole surveys of approximately 3km of drainage ditches.

Proposed Bioenergy and Composting Facility (2011)
Essex, UK

Project Ecologist responsible for coordinating and undertaking baseline ecological surveys of a former army airbase site, which is to be developed as a quarry and subsequently a bioenergy and composting facility. Surveys included bat roost emergence and re-entry surveys in a number of abandoned farmyard and army base buildings undertaken by 6 surveyors, and great crested newt population presence/absence, evidence of breeding and population assessment surveys undertaken by 5 surveyors within 250m of the site to inform European Protected Species Licence Application; and Extended Phase I Ecology survey of the site including badger surveys to inform the Ecological Impact Assessment of the EIS.

Otter Survey - Johnstown Flood Relief Works (2011)
Kildare, Ireland

Project ecologist responsible for carrying out an intensive otter survey along the banks of a river channel which is within the range of the local otter population, and which is to be dredged and widened for flood relief works. Otter usage of the site was assessed by sprainting frequency, and spraints were examined for evidence of seasonal dietary habits.

Ornithological Surveys for Proposed Wind Farm (2009)
Mayo, Ireland

Undertook monthly vantage point and walkover bird surveys on an upland site in the west of Ireland for 6 months, to gather bird site usage data in order to ultimately assess collision risks and other impacts of the construction of a wind farm across the mountainside. Surveys included walkover surveys and vantage point watches; where species, flight height and direction, and behaviour was noted for 3 hour periods at each vantage point on each survey occasion.

Leixlip Hot Springs/ Spa and Toll House (2009)
Kildare, Ireland

Project ecologist responsible for assessing common newt presence/absence in hot spring, and provision of advice to Parks Department on most appropriate season for works, and requirements for Appropriate Assessment in line with the EU Habitats Directive. Also undertook bat roost dusk emergence and dawn re-entry surveys of a derelict toll-house structure adjacent to the Royal Canal to assess the presence/absence of roosting bats.

Sallins Flood Relief Works (2010)
Kildare, Ireland

Undertook Extended Phase 1 Habitat Survey and ecological constraints mapping for proposed flood relief works. Surveys included river habitat assessment, fisheries potential assessment, and survey of trees and structures for potential bat roosts.

Coastal Habitats Survey and Mapping (2009)
Dublin, Ireland

Golder Associates were retained by Dún Laoghaire-Rathdown County Council to collect, collate and review all available biodiversity data relating to coastal and marine habitats of the 17km coastline of Dún Laoghaire Rathdown. Preliminary habitat maps were derived from aerial photography and in-house Level II habitat classification data holdings, and were ground-truthed by field survey of all accessible areas of the coastline to produce Level III classification habitat mapping. Role included desk top study and collation of available biodiversity data on the locality, and preparation and ground truthing of preliminary habitat maps to refine the habitat mapping of the coastline to Level III habitat classifications.

Geotextile Assisted Dewatering of Lakes, Naas Town Council (2008)
Kildare, Ireland

Golder was commissioned by Naas Town Council to prepare a Feasibility Study for the removal of silt from Naas Lakes, Naas, Co. Kildare, and subsequently assisted Naas Town Council in the production of tender documents for the required works. Project Ecologist responsible for undertaking a survey of nesting waterfowl on the lake and provision of recommendations regarding optimum timing of the works, in order to avoid the main bird breeding season and any significant negative impacts on local bird populations; and consulted with the Regional Fisheries Board as to their requirements for the preservation of crayfish and brook/river lamprey populations within the lakes, in order to inform the tendering process.

TRAINING

Tools for Wetland Assessment (WET-Health, WET-Ecoservices)
Rhodes University, August 2016

Mainstreaming Biodiversity into Business
National Business and Biodiversity Network, South Africa, November, 2014

First Aid Level 1
Action Training Academy, July, 2014

Wetland Management: Introduction and Delineation
University of the Free State, November. 2013

Flora of Witwatersrand
Botany Dept, University of Witwatersrand, October, 2013

Mammal Identification
The Mammal Society, May 2009

Bat Detector Workshop
Bat Conservation Ireland, June 2007, June 2008

Irish Botany
National Botanic Gardens, Glasnevin, Dublin, 2008

Outdoor Safety & First Aid
Mountain Rescue Trainer, November 2007

PROFESSIONAL AFFILIATIONS

Professional Natural Scientist (Pr. Sc. Nat. 114477/15)

Member of South African Bat Assessment Association

Member of South African Wetland Society

PUBLICATIONS

Journal Articles

Monadjem, A., L. Richards, P. J. Taylor, C. Denys, A. Dower and S. Stoffberg. Diversity of Hipposideridae in the Mount Nimba massif, West Africa, and the taxonomic status of Hipposideros lamottei. *Acta Chiropterologica*, 15(2) (2013), 341-352.

Other

The Status of EU Protected Habitats and Species in Ireland. National Parks & Wildlife Service, 2008.

Golder Associates Africa (Pty.) Ltd. – Johannesburg

Terrestrial Ecologist

Andrew Zinn is a terrestrial ecologist with Golder Associates Africa Pty Ltd. In this role he conducts terrestrial ecology studies, comprising flora and fauna surveys, for baseline ecological assessments and ecological impact assessments. He has worked on projects in several African countries including Botswana, Democratic Republic of Congo, Ghana, Mozambique, South Africa and Tanzania.

Andrew is a qualified ecologist, holding a Master of Science degree in Resource Conservation Biology from the University of the Witwatersrand. Before joining Golder's Ecology Division, Andrew worked for WSP Environment and Energy. He has also worked on a range of conservation and ecology related projects, both locally in South Africa, including work in the Kruger National Park, as well as further afield in Northern Ireland and the United Arab Emirates. Andrew is registered with the South African Council for Natural Scientific Professions as a Professional Natural Scientist - Ecological Science.

Education

MSc. Resource Conservation Biology, University of the Witwatersrand, Johannesburg, 2013

BSc. Hons. Ecology and Conservation Biology, University of KwaZulu-Natal, Pietermaritzburg, 2005

BSc. Zoology and Grassland Science, University of KwaZulu-Natal, Pietermaritzburg, 2004

Certifications

Member of the South African Wildlife Management Association, 2013

Registered with the South African Council of Natural Scientific Professions as a Professional Natural Scientist , 2015

Languages

English – Fluent

Employment History

Sub-contracted to KPMG UAE – Abu Dhabi, United Arab Emirates

Independent ecological consultant (2011 to 2011)

I was subcontracted to KPMG UAE as a subject matter expert on a team conducting an internal audit of the Conservation Department of Sir Bani Yas Desert Island, in the United Arab Emirates. The island is a conservation and tourism destination off the coast of Abu Dhabi, in the Arabian Gulf.

WSP Environment and Energy – Johannesburg

Consultant (2008 to 2011)

As an environmental consultant I was involved in a wide range of environmental projects. These included managing environmental authorisation projects (EIA and BA studies), facilitating stakeholder engagement processes, conducting compliance audits and developing environmental management programmes (EMP). I was also involved in specialist ecological projects.

Yale University/Kansas State University – Satara, Kruger National Park

Researcher (2007 to 2008)

I was employed as a research technician on the Savanna Convergence Project in the Kruger National Park, South Africa. The project is long-term, cross-continental study investigating the roles of fire and herbivory on savanna/prairie vegetation dynamics. I was responsible for the collection and analyses of vegetation and herbivore distribution data.

PROJECT EXPERIENCE – ECOLOGY

Nidvest Tank Terminals, Quarry 2 Tank Terminals KwaZulu-Natal, South Africa	Developed a rehabilitation plan for the upgrading of the Quarry 2 Tank Terminals in the Durban Harbour complex.
Frontier Mine Katanga Province, Democratic Republic of Congo	Conducted a biodiversity screening study for the Frontier Mine Concession in line with the requirements Performance Standard 6 of the International Finance Corporation (IFC), concerning Biodiversity Conservation and the Sustainable Management of Living Natural Resources.
Metalkol Mine Katanga Province, Democratic Republic of Congo	Conducted a terrestrial ecology assessment of the Metalkol Mine Concession in line with the requirements Performance Standard 6 of the International Finance Corporation (IFC), concerning Biodiversity Conservation and the Sustainable Management of Living Natural Resources.
Boss and COMIDE Mines Katanga Province, Democratic Republic of Congo	Conducted a terrestrial ecology assessment of the Boss and COMIDE Mine Concessions in line with the requirements Performance Standard 6 of the International Finance Corporation (IFC), concerning Biodiversity Conservation and the Sustainable Management of Living Natural Resources.
Kipoi Copper Mine Katanga Province, Democratic Republic of Congo	Conducted a terrestrial ecology assessment of the Kipoi Mine Concession in line with the requirements Performance Standard 6 of the International Finance Corporation (IFC), concerning Biodiversity Conservation and the Sustainable Management of Living Natural Resources.
Kipushi Mine Katanga Province, Democratic Republic of Congo	Conducted a terrestrial ecology assessment, including flora and fauna sampling, of the Kipushi Mine lease area.
Arcelor Mittal Gauteng and Western Cape, South Africa	Conducted exotic invasive plant species assessments at various Arcelor Mittal properties, including Vereeniging, Vanderbijlpark, Pretoria and Suldanha
Phalaborwa Mining Company Limpopo Province, South Africa	Conduct annual VEGRAI monitoring assessments at select sampling points along the Olifants and Selati Rivers.
Kusile Power Station Mpumalanga Province, South Africa	Completed a search and rescue operation of Red Data and Protected plants growing in the development footprint of the proposed Kusile Power Station 10 year ash stack.
Ndumo - Gezisa Power-line Project Maputaland, KwaZulu-Natal, South Africa	Conducted a terrestrial ecology assessment, including flora and fauna sampling, of the proposed route alternatives of the Ndumo-Gezisa Power-line.

Scaw Metals - Manufacturing Facilities Gauteng & Free State, South Africa	Conducted exotic invasive plant species assessment at various Scaw Metal properties to provide control and eradication recommendations.
Jwaneng Diamond Mine Southern District, Botswana	Conducted a flora assessment of undisturbed and disturbed areas at Jwaneng Diamond Mine to inform the development of a re-vegetation protocol, as part of the mines rehabilitation programme.
Komoa Copper Project Katanga Province, Democratic Republic of Congo	Participated on the terrestrial ecology assessment of the exploration area of the proposed Komoa Copper Mine.
Bulyanhulu Gold Mine Shinyana Region, Tanzania	Conducted a terrestrial ecology assessment, including flora and fauna sampling, of the site of the proposed tailings facility No. 4 at Bulyanhulu Gold Mine.
Tshikondeni Coal Mine Limpopo Province, South Africa	Conducted a terrestrial ecology assessment of theTshikondeni Coal Mine lease area, with the aim of providing a ecological baseline to inform the development of a mine rehabilitation plan.
Grootegeluk Coal Mine Limpopo Province, South Africa	Conducted an ecological sensitivities assessment of the sites of the proposed entrance road and cyclic ponds at Exxaro Coal's Grootegeluk Mine.
Mafube Colliery - Nooitgedacht Mpumalanga Province, South Africa	Conducted an ecological survey and impact assessment of the Nooitgedacht portion of the proposed Mafube Colliery.
Ruighoek Chrome Mine North-West Province, South Africa	Conducted an ecological survey and impact assessment of areas of Ruighoek Mine in which open cast pit mining has been proposed.

TRAINING

Basic Principles of Ecological Rehabilitation and Mine Closure
Centre for Environmental Management, North-West University, 2008

PROFESSIONAL AFFILIATIONS

South African Council for Natural Scientific Professions

Southern African Wildlife Management Association

PUBLICATIONS

Journal Articles

Burkepile, D.E., C.E. Burns, E. Amendola, G.M. Buis, N. Govender, V. Nelson, C.J. Tambling, D.I. Thompson, A.D. Zinn and M.D. Smith. Habitat selection by large herbivores in a southern African savanna: the relative roles of bottom-up and top-down forces. *Ecosphere*, 4(11):139 (2013), http://dx.doi.org/10.1890/ES13-00078.7.

Knapp, A.K., D.L. Hoover, J.M. Blair, G. Buis, D.E. Burkepile, A. Chamberlain, S.L. Collins, R.W.S Fynn, K.P. Kirkman, M.D. Smith, D. Blake, N. Govender, P. O'Neal, T. Schreck and A. Zinn. A test of two mechanisms proposed to optimize grassland aboveground primary productivity in response to grazing. *Journal of Plant Ecology*, 5 (2012), 357-365.

Zinn, A.D., D. Ward and K. Kirkman. Inducible defences in Acacia sieberiana in response to giraffe browsing. *African Journal of Range and Forage Science*, 24 (2007), 123-129.

Zinn, A.D.. Exploitation vs. Conservation: A Burgeoning Fifth Column -. *African Wildlife*, 61 (2007), 9-11.

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