Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Herpetofauna Baseline Study

Volspruit Mine

Draft 3

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for

Wetland Consulting Services/EcoPartners

Shavaughn Davis

shavaughnd@wetcs.co.za

+27 73 233 6110

by

Enviro-Insight CC

Luke Verburgt - *Pr.Sci.Nat.; M.Sc*

luke@enviro-insight.co.za

+27 83 784 1997

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1 INTRODUCTION AND PROJECT UNDERSTANDING

Enviro-Insight was requested to provide a suitably qualified herpetofauna specialist to undertake a baseline herpetofauna study with emphasis on two reptile species (*Crocodylus niloticus* and *Sensitive species 12*[1]) and perform an environmental impact assessment (EIA) for the proposed opencast Volspruit Mine.

The study area is defined by the amended Volspruit Mining Right area (Figure 1) and its immediate surrounding area. It is comprised predominantly of critical biodiversity areas (CBA1) as indicated by the Limpopo Province Conservation Plan V2 (LCPv2, 2013[2]) which was recently updated in 2018 (Figure 1). The closest major town is Mokopane and the study area falls in the Waterberg District Municipality of the Limpopo Province.

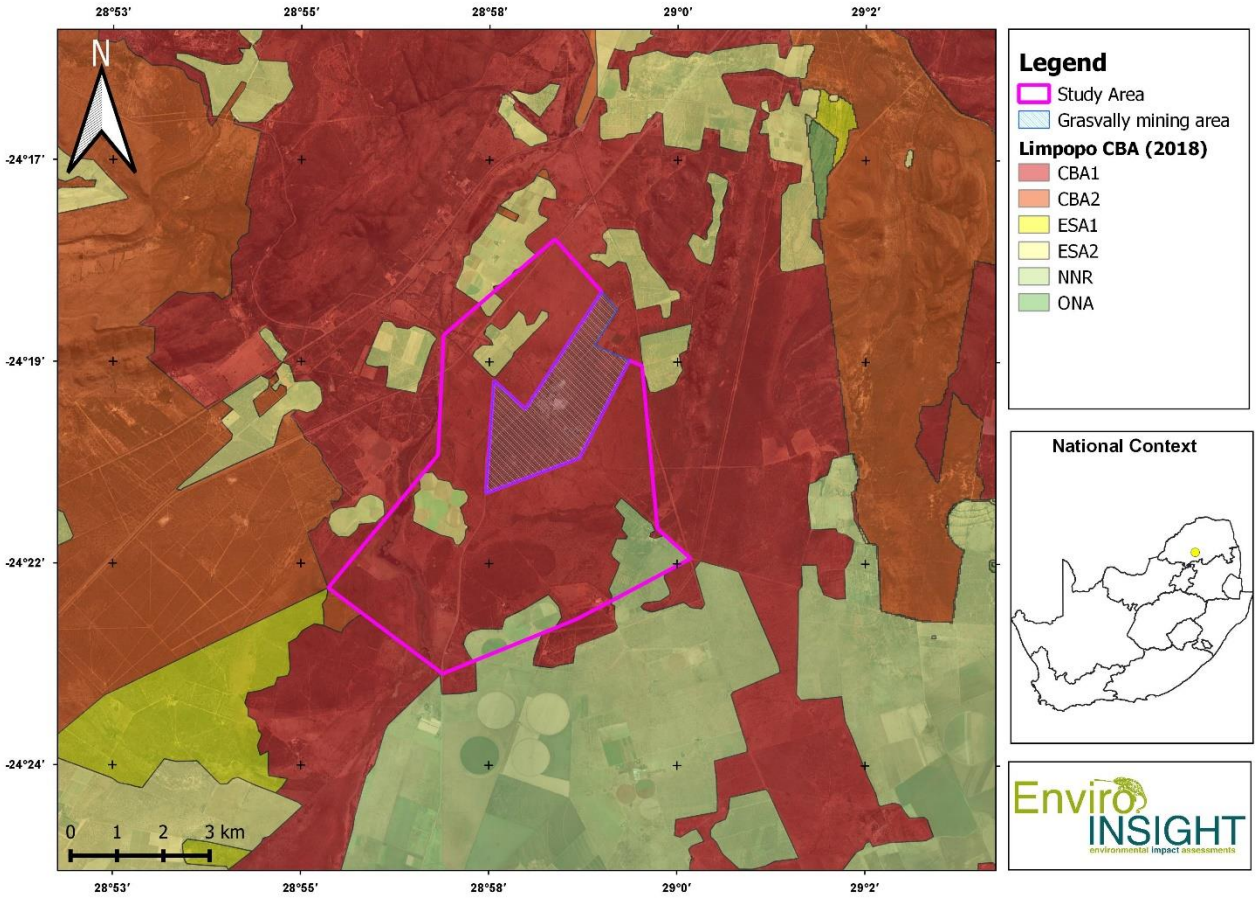


Figure 1: Location of the study area in relation to the Limpopo Province Conservation Plan V2.

The proposed mining infrastructure does not encompass the entire study area as shown in Figure 1 but is mostly restricted to the western and central portion of the study area. The exact location of the proposed infrastructure with labels indicating each component is provided in Figure 2.

[1] The screening tool report includes some species that are sensitive to illegal harvesting. Such species have had their names obscured and are listed as: sensitive plant unique number/sensitive animal unique number. The actual name of the sensitive species may not appear in the final EIA report or in any of the specialist reports released into the public domain (SANBI 2020).
2 https://bgis.sanbi.org/Projects/Detail/21

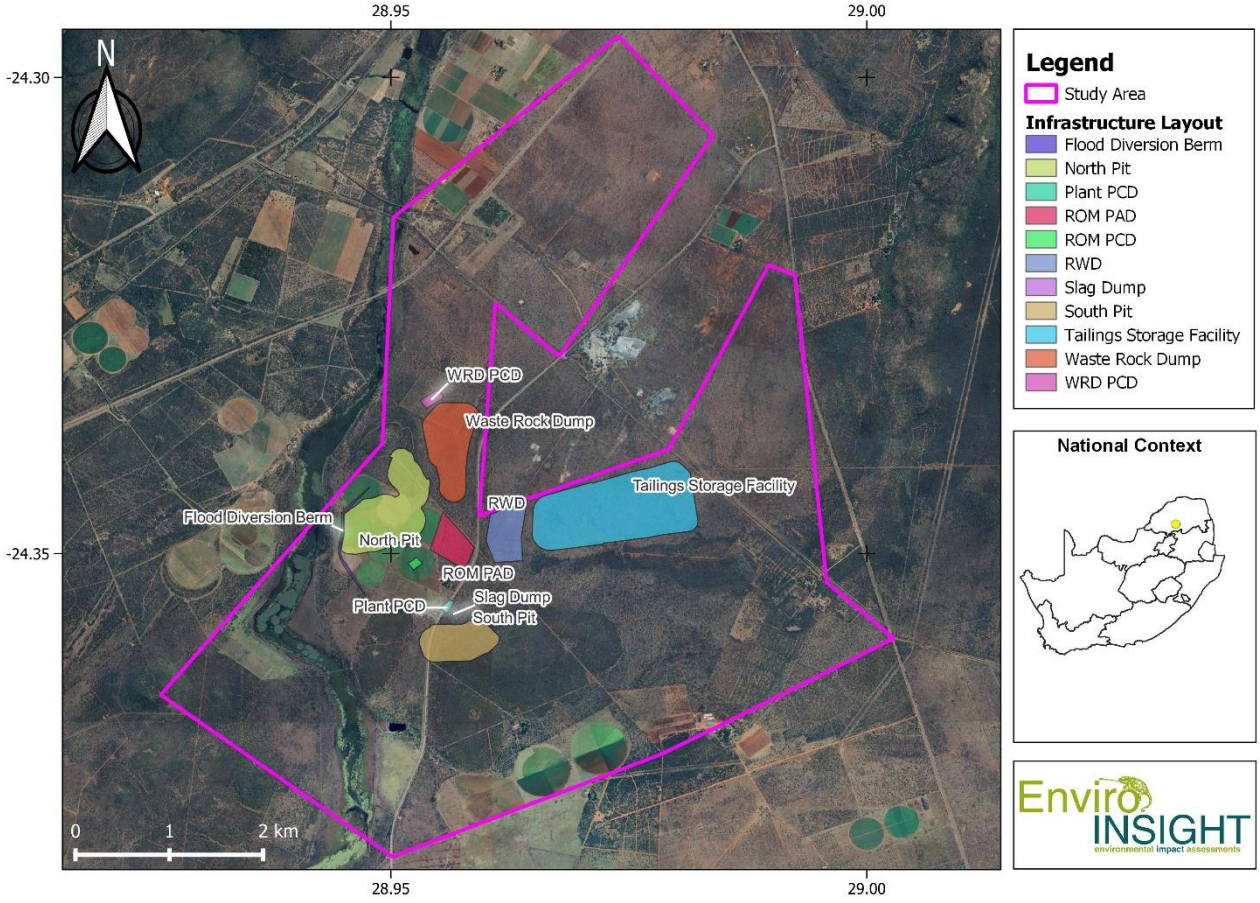


Figure 2: Proposed infrastructure layout within the study area.

2 METHODS

2.1 NATIONAL ENVIRONMENTAL SCREENING TOOL REPORTS

- In accordance with the terrestrial animal species protocol published in Government Notice No. 1150 of 30 October 2020, the National Environmental Screening Tool was consulted to provide a list of herpetofauna species of conservation concern (HSCC) potentially affected by the proposed development. This was performed during the inception of the project (January 2021) to inform specialist studies and two reptile species of conservation concern (Nile Crocodile [*Crocodylus niloticus*] and *Sensitive species 12* were identified. Following execution of the field studies, an updated Screening Tool report (December 2021) no longer included Nile Crocodile as a reptile species of concern, due to a revision of the species range (not its threatened status). Nonetheless, surveys were performed for this species and sample sites and habitat descriptions will be included in this report for the sake of completion, but no further discussion will be provided.

2.2 LITERATURE REVIEW

- All available books and publications providing information on distribution ranges and/or conservation status of South African herpetofauna were utilised to review the National Environmental Screening Tool predictions of herpetofauna species of conservation concern (HSCC) occurrence in the mining right area (e.g. Branch 1998; Bates *et al*. 2014; du Preez & Carruthers 2017; Channing & Rödel 2019, Rhodin et al. 2021).
- Additional observation localities of herpetofauna were obtained from citizen science projects such as the online Virtual Museum (VM) facilities of the FitzPatrick Institute of African Ornithology of the University of Cape Town (http://vmus.adu.org.za): ReptileMAP (2021) and FrogMAP (2021); and iNaturalist (http://www.inaturalist.org).
- No relevant Biodiversity Management Plans for HSCC were identified.
- Reptile species nomenclature follows ReptileMAP (2021) and amphibian nomenclature follows FrogMAP (2021), as these online resources provide more updated nomenclature than printed reference material.
- The National Red List[3] was utilised to provide the most current account of the conservation status of reptiles and amphibians.

2.3 DIURNAL ACTIVE SEARCHING & HABITAT CHARACTERISATION

The target HSCC were searched for while on foot within and adjacent to the project area of influence (PAOI) during the day. Specific sample sites were selected based on habitat preferences of the HSCC. This involved firstly describing the habitat of sample sites and taking representative photographs followed by active searching for herpetofauna for up to 90 minutes per sample site. In addition, local farmer and farm workers in the project area were questioned regarding any sightings that might represent one of the HSCC, details such as the location of the sighting were recorded if possible.

Active searching for reptiles included the following:

- Photographing active reptiles from a distance with a telephoto lens;
- Lifting and searching under debris or rocks (rocks were returned to their original positions). This is because *Sensitive Species 12* often shelters under rocks;
- Scanning for any signs of reptiles such as tortoise shells, crocodile tracks or slides etc., the positive identification of which was taken as an observation of that species; and
- Catching any observed active reptile by hand.

All observed/captured reptiles and amphibians were photographed and released unharmed.

2.4 NOCTURNAL ACTIVE SEARCHING

Crocodiles are most easily observed at night due to the ease of detecting their eye shine with a powerful light source. Nile Crocodiles were searched for by torchlight at night in the aquatic habitats that were characterised during the day.

3 http://speciesstatus.sanbi.org/

2.5 HABITAT MAPPING

2.5.1 Vegetation/habitats

Vegetation units were mapped within the study area by Wetland Consulting Services (WCS). These mostly botanical delineations were converted to more structural habitat units of relevance for herpetofauna, by the combination of certain vegetation units into a single macro-habitat. This process resulted in the identification of four structural habitat types which are expected to have distinct herpetofauna communities. A fifth habitat type was added based on the presence of exposed rocks on elevated positions (rocky ridges or koppies, see below).

2.5.2 Topographic position

High resolution (~12.5 m) digital elevation models (DEMs) from the ALOS PALSAR mission were obtained from the Alaska Satellite Facility[4]. These data were pre-processed and analysed with SAGA[5] to produce a raster image indicating the position of potential rocky ridges (koppies) using the *Topographic Position Index* (TPI) geoprocessing module. The resulting raster cells with TPIs > 2 were reclassified to indicate ridges standing out from the surrounding landscape. Because only meaningfully large expanses of appropriate habitat should be mapped as management units, the raster was vectorised, areas were calculated for each potential rocky ridge polygon and only those with areas > 3 ha were retained to indicate potentially rocky ridges (koppies).

2.5.3 Landscape slope processing

A literature survey was conducted to obtain international best practice guidelines regarding the protection of sensitive slopes. Most sources have consensus regarding the avoidance and / or protection of "steep" slopes in development and / or exploration activities. However, there is no consensus on the definition of what constitutes a "steep" slope.

In order to properly define "steep" a literature review was performed (Table 1). As can be seen from this assessment, there is no general consensus on the appropriate slope limitation above which the terrain can be considered ecologically sensitive. The only consideration in this regard for Africa originates from the “Draft Development Guidelines for Ridges” (Pfab 2001) which defines the “ridge” as “any topographic feature in the landscape that is characterized by slopes of 5° or more (i.e. ≥ 8.8%, ≥ 1 in 11 gradient). According to the Gauteng Department of Agriculture and Rural Development (GDARD) requirements for biodiversity assessments for Gauteng Province (GDARD 2014):

"All ridges must be designated as sensitive..... Where the interface between the lower slopes and adjacent land is deemed important for certain species (e.g. low density herbivores recorded on site and important/rare invertebrates), a buffer zone of 200m must be mapped and designated as sensitive. A 200m buffer zone for Class 1 ridges must be designated as sensitive."

The same ALOS PALSAR DEM as above was used for the slope analysis using the *Slope, Aspect, Curvature* geoprocessing module of the SAGA[6] GIS software. The resulting slope raster was reclassified to show slopes steeper than 5° (Pfab, 2001). As for topographic position index, this raster was vectorised, areas were calculated for each potential

[4] https://search.asf.alaska.edu/
[5] System for Automated Geoscientific Analyses - http://www.saga-gis.org/
[6] www.saga-gis.org

rocky ridge and only those with areas > 3 ha were retained to indicate potentially suitable rocky ridges for *Sensitive species 12*. Only the large (> 3 ha), sloped areas that coincided with the rocky ridges detected by the TPI analysis above were retained to indicated rocky ridges and their sloped foothills, which were buffered by 200 m as recommended by GDARD (2014). This habitat unit was treated as distinct and called "koppies".

Table 1: Slope limitations according to available literature sources

Country / Municipality / City	Guideline / Book	Activity	Slope limitation (%)[7]	Slope limitation (degrees)	Purpose
City of Cotati, California, USA	Cotati Municipal Code Chapter 17.53 Hillside and Ridgeline Development (Codepublishing.com 2016)	Grading / construction (development)	> 15	>8.53	Environmental degradation (i.e. vegetation, surface water runoff)
Seattle, Washington, USA	Seattle, Washington - Municipal Code (Seattle.gov 2016)	Development	>40	>21.80	Public health and safety (i.e. landslides), environmental degradation (i.e. vegetation, surface water runoff)
Harrison Township, Pennsylvania, USA	Steep Slope Ordinance (Conservationtools.org 2010)	Development	>20	>11.31	Public health and safety; soil protection; watershed protection; ecological connectivity
East Nantmeal Township, Pennsylvania, USA	Steep Slope Ordinance (Conservationtools.org 2010)	Development	>15	>8.53	Public health and safety; soil protection; watershed protection; ecological connectivity
USA	Design with nature	Cultivation and development	>21.26	>12	Soil protection and public safety
Gauteng, South Africa	Development Guidelines for Ridges (GDARD 2014)	Development	>8.8	>5	Biodiversity protection

2.6 ENVIRONMENTAL IMPACT ASSESSMENT

The methodology to assess environmental impacts was provided by Wetland Consulting Services (WCS). Each anticipated impact was evaluated according to its status, magnitude, extent, duration, and probability of occurrence. These evaluations were based on predefined categories associated with numerical scores as shown in Table 2. The impact significance was then calculated from the numerical scores as follows:

[7] calculated as a percentage of vertical over horizontal distance

Significance = (Magnitude + Duration + Extent) x Probability

The maximum value that can be reached through the described impact evaluation process is 100 SP[8]. The scenarios for each environmental impact were rated as High (SP≥60), Moderate (SP 31-60) and Low (SP<30) significance as shown in Table 3.

Once the significance rating of an impact before mitigation has been determined, the reversibility of the impact, 'replaceability' of the affected resources and the potential of the impact to be further mitigated also need to be determined. These factors are explained in Table 4 below, and play an important role in the determination of the level and type of mitigation performed or to be implemented. Table 4 sets out the criteria that should be used to assess the reversibility, loss of resources and potential for further mitigation.

Table 2: Impact assessment considerations and their associated categories and numerical scores

Status		
Positive	+	Impact will be beneficial to the environment (a benefit).
Negative	-	Impact will not be beneficial to the environment (a cost).
Neutral	0	Where a negative impact is offset by a positive impact, or mitigation measures, to have no overall effect.
Magnitude		
Minor	2	Bio-physical and/or social functions and/or processes will remain unaltered.
Low	4	Bio-physical and/or social functions and/or processes might be negligibly altered or enhanced.
Moderate	6	Bio-physical and/or social functions and/or processes might be notably altered or enhanced.
High	8	Bio-physical and/or social functions and/or processes might be considerably altered or enhanced.
Very high	10	Bio-physical and/or social functions and/or processes might be severely/substantially altered or enhanced.
Extent		
Site only	1	Effect limited to the site and its immediate surroundings.
Local	2	Effect limited to within 3-5 km of the site.
Regional	3	Activity will have an impact on a regional scale.
National	4	Activity will have an impact on a national scale.
International	5	Activity will have an impact on an international scale.
Duration		
Immediate	1	Effect occurs periodically throughout the life of the activity.

[8]SP: Significant Points.

Short term	2	Effect lasts for a period 0 to 5 years.
Medium term	3	Effect continues for a period between 5 and 15 years.
Long term	4	Effect will cease after the operational life of the activity either because of natural process or by human intervention.
Permanent	5	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient.
Probability of occurrence		
Improbable	1	Less than 30% chance of occurrence.
Low	2	Between 30 and 50% chance of occurrence.
Medium	3	Between 50 and 70% chance of occurrence.
High	4	Greater than 70% chance of occurrence.
Definite	5	Will occur, or where applicable has occurred, regardless or in spite of any mitigation measures.

Table 3. Definition of significance rating

Significance of predicted NEGATIVE impacts		
Low	0-30	Where the impact will have a relatively small effect on the environment and will require minimum or no mitigation. Ensure impact remains low through the application of appropriate mitigation measures where applicable.
Medium	31-60	Where the impact can have an influence on the environment and strict mitigation measures should be implemented to lower impacts and manage the project impacts appropriately
High	61-100	Where the impact will definitely influence the environment. Impact should be avoided as far as possible. Implement strict mitigation measures to account for residual impacts and must be mitigated, where possible.
Significance of predicted POSITIVE impacts		
Low	0-30	Where the impact will have a relatively small positive effect on the environment.
Medium	31-60	Where the positive impact will counteract an existing negative impact and result in an overall neutral effect on the environment.
High	61-100	Where the positive impact will improve the environment relative to baseline conditions.

Table 4: Additional considerations of each impact related to the reversibility of impact, irreplaceability of the resource being impacted and the potential for mitigation measures to be effective.

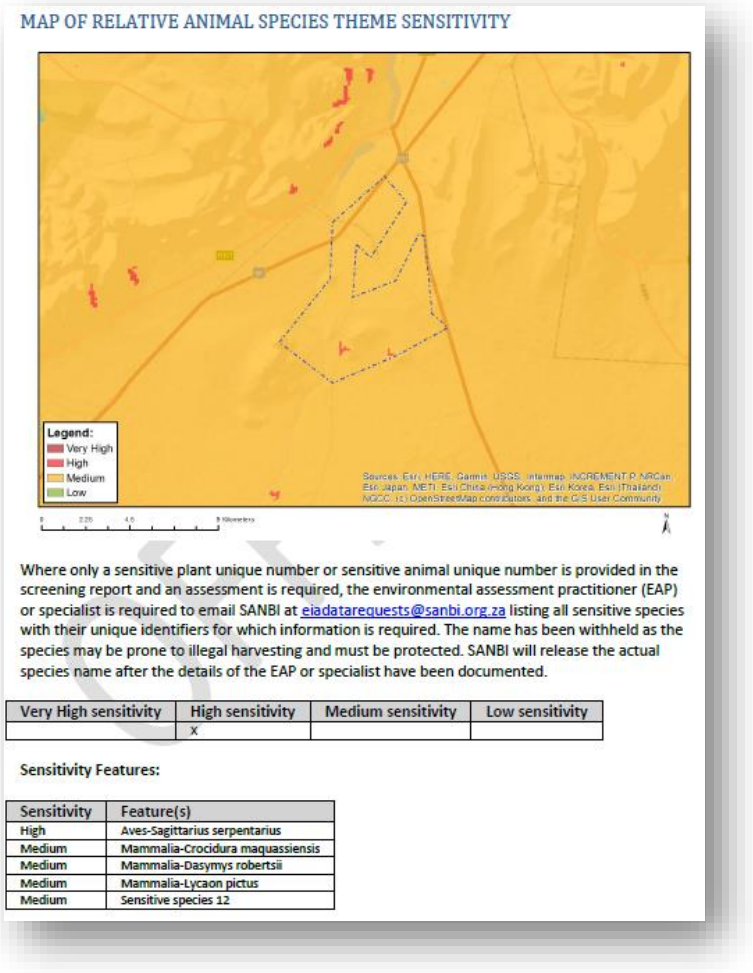
Reversibility of impact		
Reversible	1	The impact on natural, cultural and / or social structures, functions and processes is totally reversible.
Partially	2	The impact on natural, cultural and / or social structures, functions and processes is partially reversible.
Irreversible	3	Where natural, cultural and / or social structures, functions or processes are altered to the extent that it will permanently cease, i.e. impact is irreversible.
Irreplaceable loss of resources		

Replaceable	1	The impact will not result in the irreplaceable loss of resources.
Partially	2	The Impact will result in a partially irreplaceable loss of resources.
Irreplaceable	3	The impact will result in the irreplaceable loss of resources.
Potential of impacts to be mitigated		
High	1	High potential to mitigate negative impacts to the level of insignificant effects, or to improve management to enhance positive impacts.
Medium	2	Potential to mitigate negative impacts. However, the implementation of mitigation measures may still not prevent some negative effects.
Low	3	Little or no mechanism exists to mitigate negative impacts.

3 RESULTS

3.1 REVIEW OF NATIONAL ENVIRONMENTAL SCREENING TOOL LIST

The list generated (December 2021) by the National Environmental Screening Tool was found to accurately report the HSCC expected for the study area (Figure 3).


MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY

Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	x		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Sagittarius serpentarius
Medium	Mammalia-Crocidura maquassiensis
Medium	Mammalia-Dasymys robertsii
Medium	Mammalia-Lycaon pictus
Medium	Sensitive species 12

Figure 3:Screening Tool Report on the Animal Species Theme.

3.2 SAMPLE SITES AND COVERAGE

A total of 20 herpetofauna sample sites were searched during the fieldwork survey, four of which were re-sampled at night for crocodiles (Figure 4). Detailed habitat descriptions and representative photographs are provided for each sample site in Appendix 1.

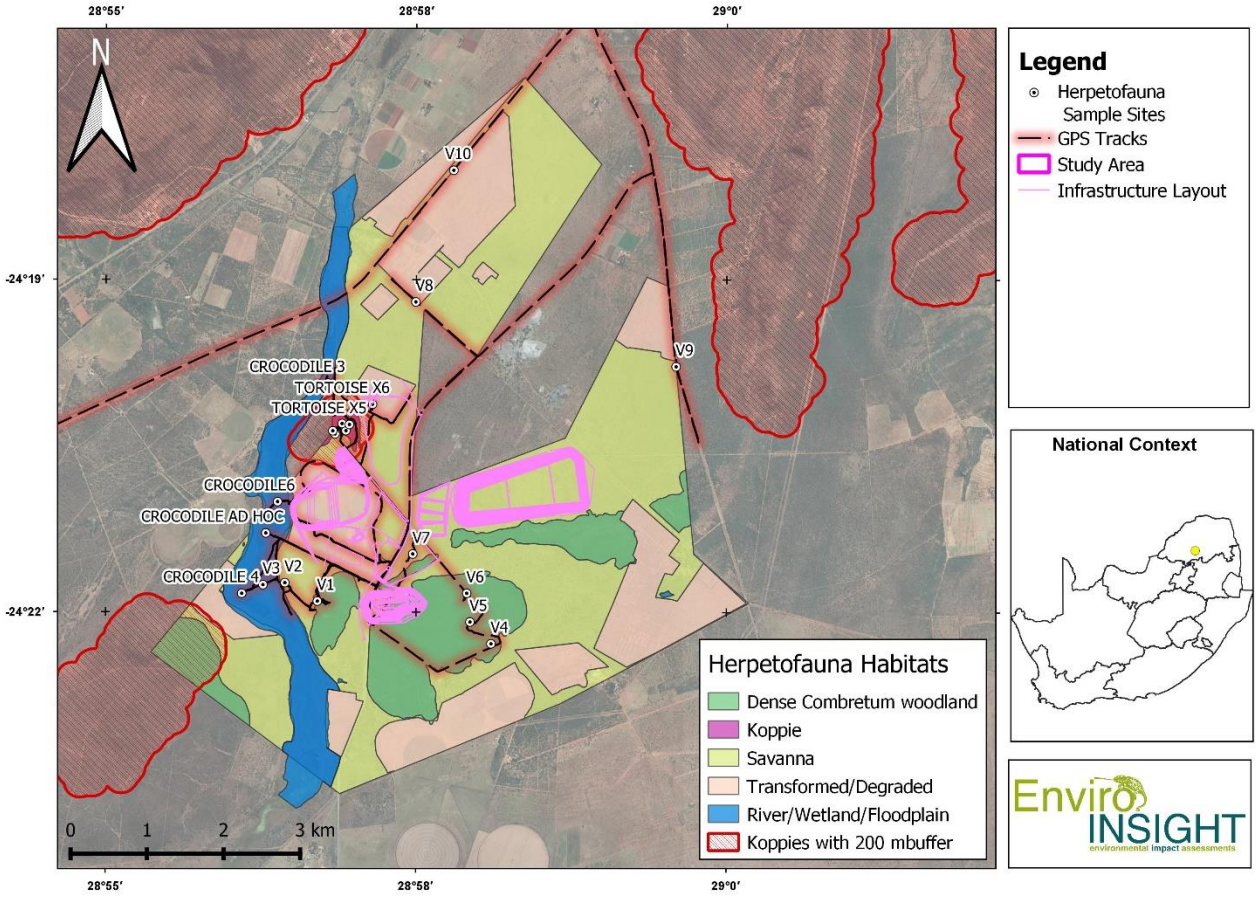


Figure 4: Herpetofauna samples sites, specialist tracks and herpetofauna habitats in relation to the study area.

3.3 HERPETOFAUNA OBSERVATIONS

Neither of the target HSCC were observed during the field survey. However, the habitat suitability survey for *Sensitive Species 12* revealed seemingly ideal habitat located within the study area. No other HSCC were observed or are expected to occur in the PAOI. Other herpetofauna observed during the survey include four common reptile species [Turner's Gecko *(Chondrodactylus turneri),* Common Tropical House Gecko *(Hemidactylus mabouia),* Common Variable Skink *(Trachylepis varia),* South African Marsh Terrapin *(Pelomedusa galeata)*] and nine amphibian species (Banded Rubber Frog (*Phrynomantis bifasciatus*) [only heard calling] and the eight species shown in Figure 5).



Figure 5: Representative photographs of eight of the nine amphibian species observed during the fieldwork survey[9].

3.4 SENSITIVE SPECIES 12

This near-endemic species is associated with rocky hillsides in mixed woodlands of the Bushveld, where it often brumates (enter a state of 'deep sleep') in rock crevices or abandoned animal burrows (Branch 2012; Hofmeyer & Boycott 2017). It is currently listed, regionally and globally, as Vulnerable (Hofmeyer & Boycott 2017; Hofmeyer & Boycott 2018), with major threats including habitat destruction and degradation, use of fire as a management tool and collection for food or the pet trade. This species was not observed directly within the study area and none of the farmers or farm workers encountered had ever observed this species (photographs were shown). However, this species is almost certain to occur within the study area (Figure 6) and as stated above and in Appendix 1, potentially good habitat for this species was also encountered and described within the study area. Given the recent geographic range extension of the species which was based on genetically confirmed individuals (Ihlow et al. 2020), it is questionable whether this species can truly be considered as Vulnerable under the IUCN Criteria since the extent of occurrence (EOO; estimated to be ~ 93,000 km^2 based on Ihlow et al. [2020]), number of threat locations and presence of this species in numerous protected areas suggests that it is currently not threatened[10]. Nevertheless, this species must be treated as a HSCC until such a time as the status is revised.

[9] Top to bottom, left to right: *Olive Toad (Sclerophrys garmani), (Red Toad (Schismaderma carens), Bushveld Rain Frog (Breviceps adspersus), African Bull Frog (Pyxicephalus edulis), Bubbling Kassina (Kassina senegalensis), Tremelo Sand Frog (Tomopterna cryptotis), Plain Grass Frog (Ptychadena anchietae), Broadbanded Grass Frog (Ptychadena mossambica).*

[10] In the absence of reliable population level data to infer major reductions in population numbers

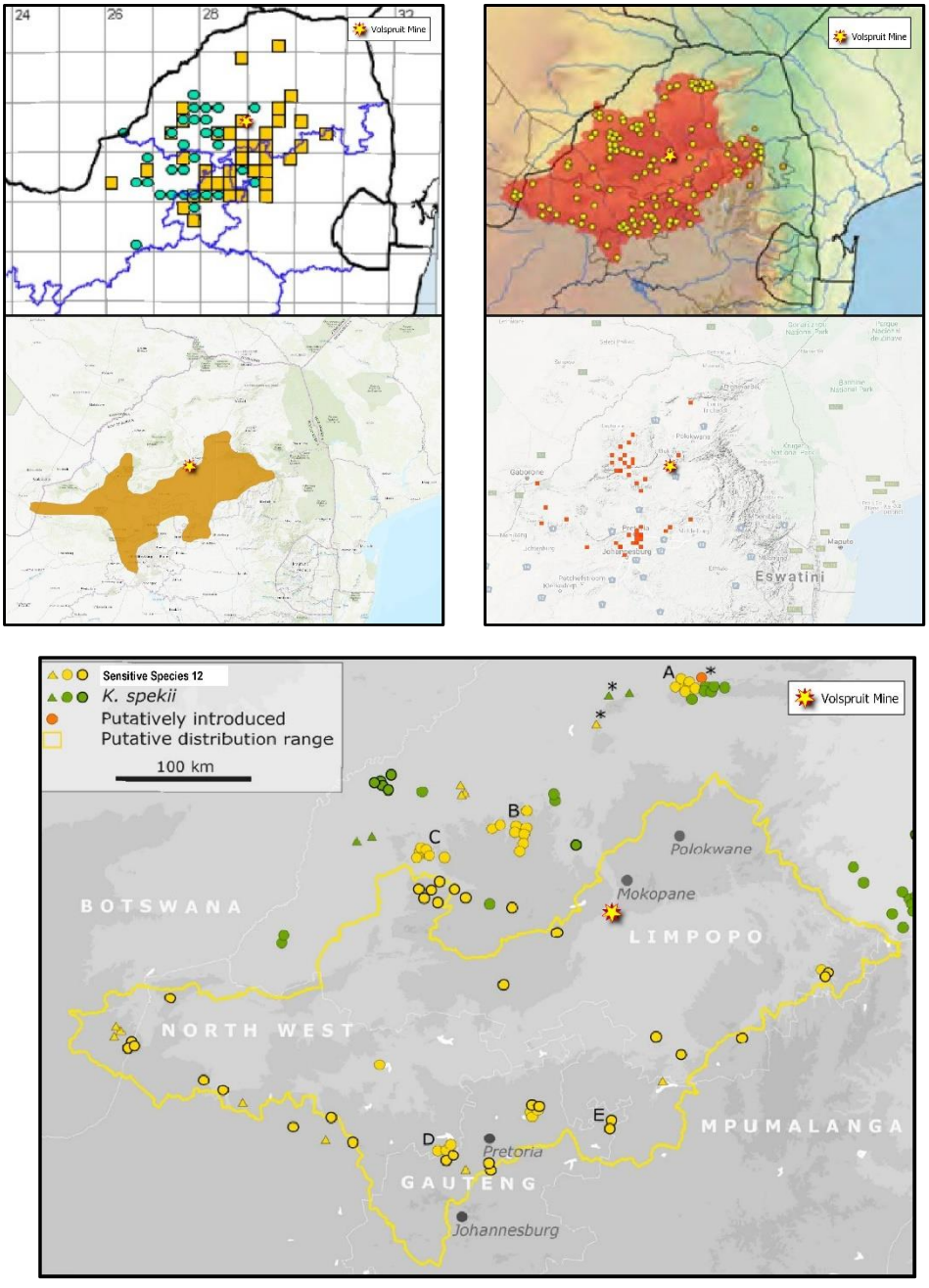


Figure 6: Known records of Sensitive Species 12 in relation to the mining right area[11].

3.5 CURRENT IMPACTS

Only two major current impacts on herpetofauna and their habitats were observed within and adjacent to the mining right area during the herpetofauna survey:

- Habitat loss & degradation - large areas of natural habitat have been transformed and/or degraded, predominantly

[11]Left Top: ReptileMAP (2021). Left Bottom: Hofmeyr & Boycott (2018). Top right: Rhodin et al. (2021). Bottom right: iNaturalist (2021). Bottom-most: Ihlow et al. (2020)

due to crop agriculture. The adjacent mining operations (Grass Valley Chrome Mine) have also caused some habitat loss in the area. The remaining habitat is generally managed as game farms or used for low density cattle grazing.

- Roads - the mining right area is surrounded by two major national roads namely the N1 and N11. These busy roads almost certainly result in the roadkill of many species. The group to which *Sensitive Species 12* belongs are particularly vulnerable to collision with fast moving vehicles as they are slow-moving and cannot react quickly to oncoming traffic.

3.6 SITE ECOLOGICAL IMPORTANCE (SEI)

As described in the species protocol guidelines (SANBI 2020), Site Ecological Importance (SEI) is a "standardised metric for identifying site-based ecological importance for species, in relation to a proposed project with a specific footprint and suite of anticipated activities". SEI allows for rapid spatial inspection and evaluation of impacts of a proposed development within the context of on-site habitats and SCC, and also facilitates integration of inputs from different specialist studies.

SEI was evaluated for each of the habitats mapped (Figure 4) in the study area, and the detailed evaluation is presented in Table 5 below. The spatial representation of this SEI evaluation, with the application of buffers, is presented in Figure 7, from which can be seen that the proposed project infrastructure has minimal interaction with the High SEI and mostly interacts with the Medium SEI.

Buffers

The species protocol guidelines (SANBI 2020) prescribe recommended buffers around habitats utilised by species of conservation concern. For *Sensitive Species 12* the prescribed buffers around sensitive habitats is 100 m. However, due to the delineated sensitive habitats being buffered with 200 m as per recommendation from GDARD (2014), no additional buffers were applied.

Table 5: Evaluation of Site Ecological Importance (SEI) of herpetofauna habitats in the study area. BI = Biodiversity Importance.

Habitat	Conservation Importance	Functional Integrity	Receptor Resilience	Site Ecological Importance
River/Wetland/Floodplain	**Low** - No confirmed or highly likely populations of SCC or range-restricted species.	**Very High** - Very large (> 100 ha) intact area for any conservation status of ecosystem type, high habitat connectivity serving as functional ecological corridors, minimal current negative ecological impacts	**High** - Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality	**LOW** **(BI = Medium)**
Savanna	**Low** - No confirmed or highly likely populations of SCC or range-restricted species. Individuals of *Sensitive Species 12* are expected to utilise this habitat mostly for migration between other optimal habitats.	**Very High** - Very large (> 100 ha) intact area for any conservation status of ecosystem type, high habitat connectivity serving as functional ecological corridors, minimal current negative ecological impacts	**Medium** - Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality	**MEDIUM** **(BI = Medium)**
Koppie	**Medium** - Highly likely occurrence of populations of threatened species listed under Criterion A only and which have more than 10 locations - *Sensitive Species 12* is listed as VU A4cde (Hofmeyr & Boycott 2018).	**High** - Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type, only minor current negative ecological impacts.	**Very Low** - Habitat that is unable to recover from major impacts – complete functionality cannot be restored if excavations take place on the koppie itself	**HIGH** **(BI = Medium)**
Transformed/Degraded	**Very low** - No confirmed or highly likely populations of SCC or range-restricted species. No natural habitat remaining.	**Very low** - Several major current negative ecological impacts	**Very High** - Habitat that can recover rapidly	**VERY LOW** **(BI = Very Low)**
Dense *Combretum* woodland	**Medium** - Highly likely occurrence of populations of threatened species listed under Criterion A only and which have more than 10 locations - *Sensitive Species 12* is listed as VU A4cde	**Very High** - Very large (> 100 ha) intact area for any conservation status of ecosystem type, high habitat connectivity serving as functional ecological corridors, minimal current negative ecological impacts	**High** - Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor.	**MEDIUM** **(BI = High)**

Habitat	Conservation Importance	Functional Integrity	Receptor Resilience	Site Ecological Importance
	(Hofmeyr & Boycott 2018).			

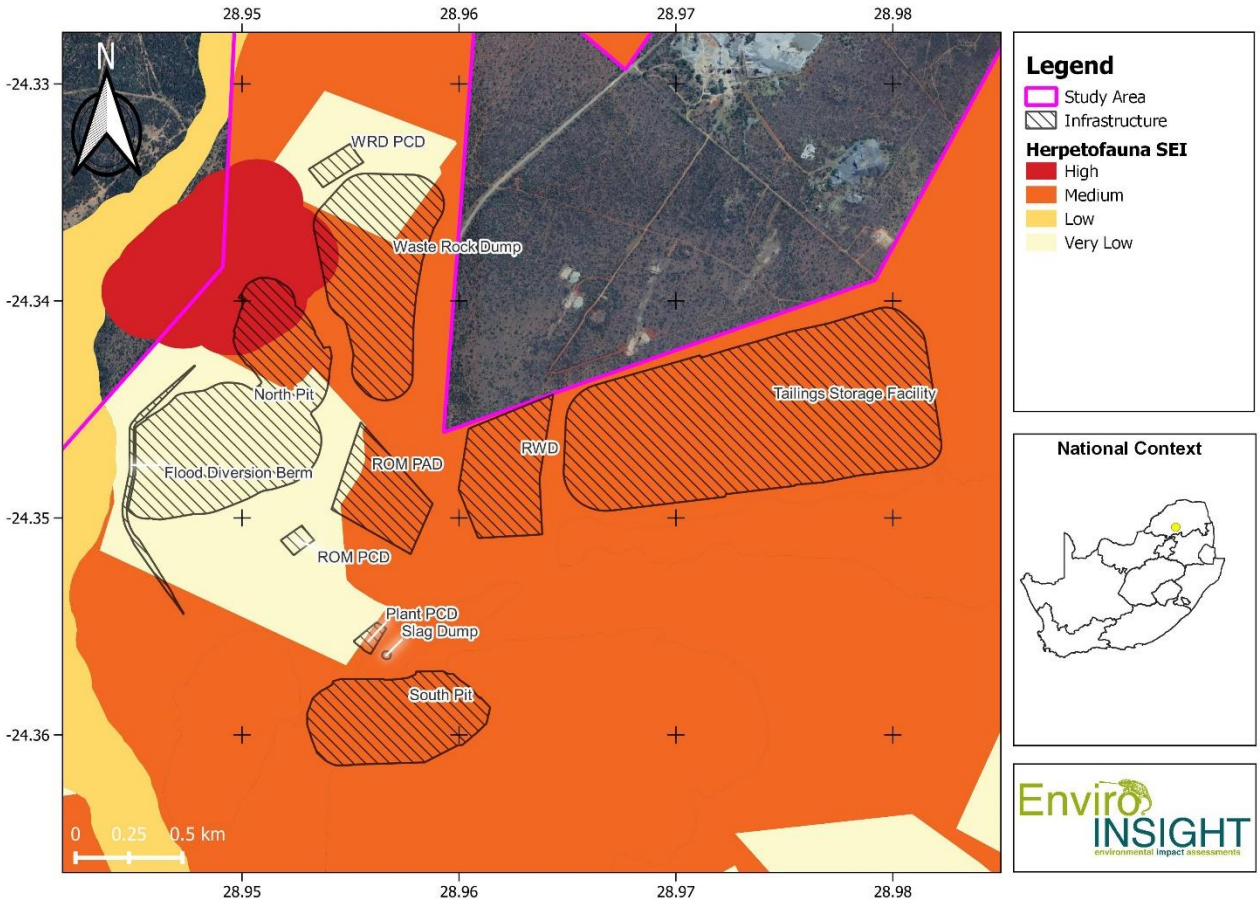


Figure 7: Herpetofauna Site Ecological Importance (SEI) of the study area.

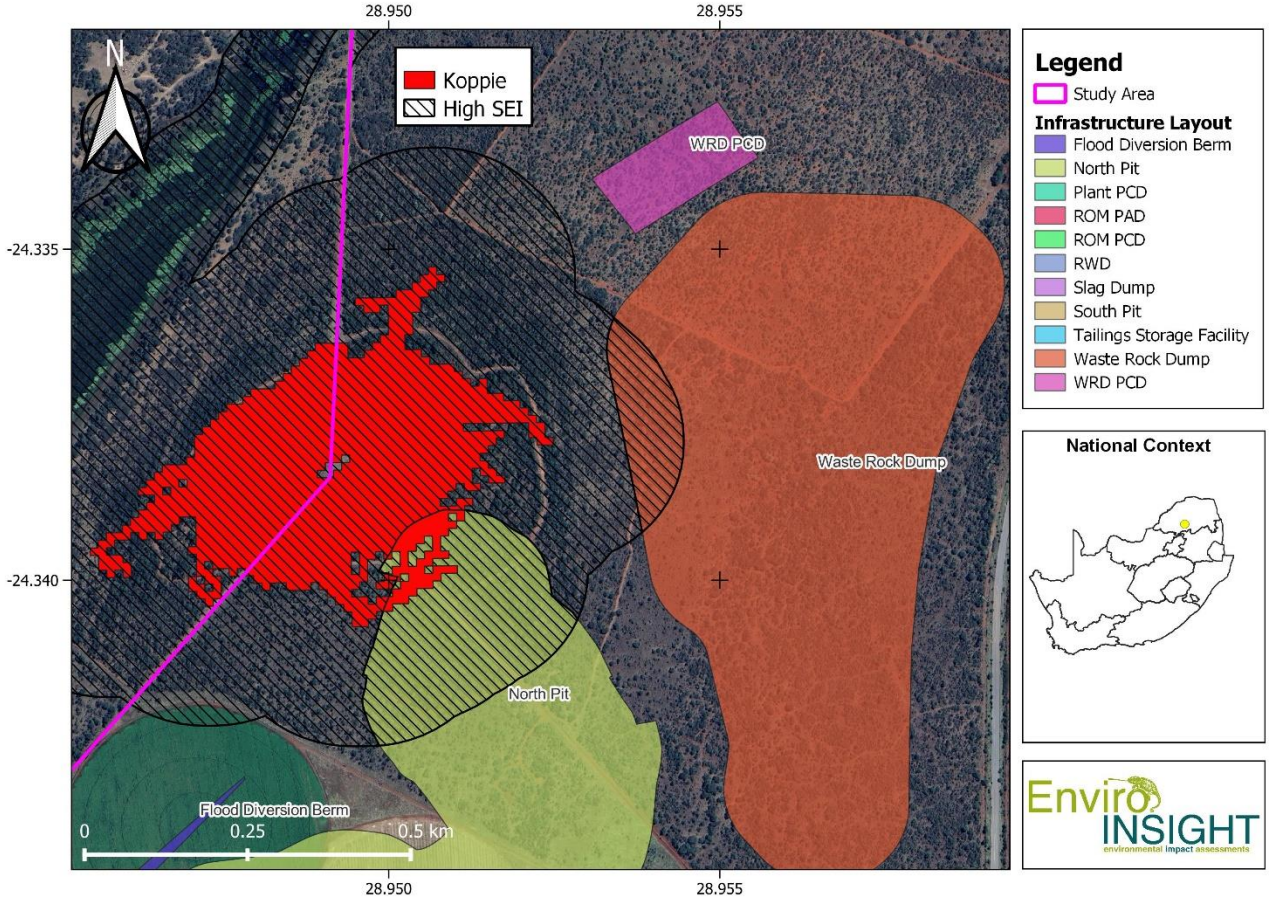


Figure 8: Important herpetofauna habitats and their buffers overlapping proposed infrastructure.

3.7 MAJOR ANTICIPATED IMPACTS TO *SENSITIVE SPECIES 12*

A comprehensive environmental impact assessment (EIA) following the methodology set out in 2.6 Environmental Impact Assessment has been compiled and is presented in 3.8 Environmental Impact Assessment. The following represents a short discussion on the potential major impacts to *Sensitive Species 12* in relation to the site ecological importance evaluated above.

- Habitat loss & degradation - the northern pit and waste rock dump overlap with the High SEI habitats of the koppie (8.4 ha and 2.4 ha respectively) (Figure 7 & Figure 8). However, the majority of this overlap is due to the proposed infrastructure overlapping with the 200 m buffer of the sensitive koppie habitat. The koppie itself is only overlapped by the northern mining pit by 0.84 ha. SANBI (2020) recommends avoidance mitigation wherever possible for High SEI areas. In the case of the waste rock dump, it should be possible to slightly rearrange the boundaries to prevent overlap with the High SEI area. Unfortunately, avoidance mitigation is unlikely to be applicable for the northern pit, as this is where the resource is located. SANBI (2020) recommends offset mitigation for high impact activities within High SEI. However, given that this habitat has already been buffered by 200 m and the northern pit will only remove 0.84 ha of the koppie habitat, it is unlikely to represent a significant loss of habitat for *Sensitive*

Species 12 if extreme care is taken to limit the edge of the pit to the demarcated area and other infrastructure not included in the map (e.g. roads) strictly avoid these High SEI areas. In addition, permanent movement barriers (rigid plastic fencing [~30 cm high] is cheap and works well) for *Sensitive Species 12* must be erected around the edge of the pit to prevent them from entering this area. These barriers must be checked regularly (monthly) for integrity and functionality. Appropriate management of the remaining natural areas within the mining right area, especially the intact portion of the koppie, will be key to maintaining a viable population of *Sensitive Species 12* in the region. It is recommended that low intensity cattle farming or game ranching should continue wherever possible within the mining right area to allow the persistence of this species.

- Roads - several roads will be constructed within the mining right area which are expected to carry heavy traffic. Such additional high traffic volumes by large machinery can be expected to significantly increase the likelihood of *Sensitive Species 12* fatalities. Appropriate minimisation mitigation measures should be put in place to minimise any potential road mortalities, which must be coupled with an appropriate monitoring programme to rapidly detect mortalities and initiate corrective measures to the mitigation approach.
- Collection for food/trade - the presence of many staff is likely to increase the likelihood of *Sensitive Species 12* being collected for food or trade purposes. This can be mitigated through appropriate training of staff and strict access control to natural areas.

3.8 ENVIRONMENTAL IMPACT ASSESSMENT

The major anticipated impacts to HSCC described above were evaluated according to the impact assessment methodology set out in 2.6 Environmental Impact Assessment and is presented in Table 6 along with proposed mitigation measures to avoid or minimise the anticipated impacts. From the context provided by Table 3, impacts are not considered to be of High significance following appropriate mitigation. The impact of habitat loss and degradation does however remain of medium significance following implementation of mitigation (Table 6), because the loss of habitat is unavoidable due to the resource and therefore north pit location (Figure 7). There are no expected differences in the impacts between the construction, operational and decommissioning phases, except that the latter phase is not expected to include any activities that will cause further habitat loss/degradation.

Table 6: Environmental impact assessment for potential impacts related to herpetofauna species of conservation concern.

No.	Environmental Component	Potential Impact	Rating (prior to mitigation)									Proposed Mitigation Measures	Rating (post-mitigation)				
			Status	Magnitude	Extent	Duration	Probability	Significance	Reversibility	Irreplaceable loss of resources	Potential of impacts to be mitigated		Magnitude	Extent	Duration	Probability	Significance
CONSTRUCTION PHASE																	
1	**Herpetofauna**	Habitat loss & degradation of High SEI habitats	-	4	1	4	5	45	3	3	3	High SEI Habitat destruction cannot be avoided due to pit location. However, waste rock dump can be moved outside of the High SEI area. Movement barriers for tortoises must be erected around the edge of the pit in the High SEI area.	4	1	4	4	36
2	**Herpetofauna**	Roads & roadkill	-	8	2	4	4	56	1	1	2	Speed restrictions, especially on roads within 400 m of the High SEI area. Drivers to be educated to look out for and avoid tortoises crossing the road. Movement barriers for tortoises must be erected along road stretches where tortoises have been observed to cross roads or where road mortalities have been observed (monitoring)	4	1	4	2	18
3	**Herpetofauna**	Collection for food/trade	-	6	2	4	3	36	1	1	1	All staff to be educated regarding respect for biodiversity on site. No staff members allowed to hunt, capture or remove any fauna from site. Penalties and fines as well as risk of contract termination to be imposed following infringement of these restrictions. Regular Toolbox talks to reaffirm importance of biodiversity and prohibition of collection thereof.	4	2	4	1	10
OPERATIONAL PHASE																	
1	**Herpetofauna**	Habitat loss & degradation of High SEI habitats	-	4	1	4	5	45	3	3	3	High SEI Habitat destruction cannot be avoided due to pit location. However, waste rock dump can be moved outside of the High SEI area. Movement barriers for tortoises must be erected around the edge of the pit in the High SEI area.	4	1	4	4	36
2	**Herpetofauna**	Roads & roadkill	-	8	2	4	4	56	1	1	2	Speed restrictions, especially on roads within 400 m of the High SEI area. Drivers to be educated to look out for and avoid tortoises crossing the road. Movement barriers for tortoises must be erected along road stretches where tortoises have been observed to cross roads or where road mortalities have been observed (monitoring)	4	1	4	2	18
3	**Herpetofauna**	Collection for food/trade	-	6	2	4	3	36	1	1	1	All staff to be educated regarding respect for biodiversity on site. No staff members allowed to hunt, capture or remove any fauna from site. Penalties and fines as well as risk of contract termination to be imposed following infringement of these restrictions. Regular Toolbox talks to reaffirm importance of biodiversity and prohibition of collection thereof.	4	2	4	1	10
DECOMMISSIONING PHASE																	
1	**Herpetofauna**	Roads & roadkill	-	8	2	4	4	56	1	1	2	Speed restrictions, especially on roads within 400 m of the High SEI area. Drivers to be educated to look out for and avoid tortoises crossing the road. Movement barriers for tortoises must be erected along road stretches where tortoises have been observed to cross roads or where road mortalities have been observed (monitoring)	4	1	4	2	18
2	**Herpetofauna**	Collection for food/trade	-	6	2	4	3	36	1	1	1	All staff to be educated regarding respect for biodiversity on site. No staff members allowed to hunt, capture or remove any fauna from site. Penalties and fines as well as risk of contract termination to be imposed following infringement of these restrictions. Regular Toolbox talks to reaffirm importance of biodiversity and prohibition of collection thereof.	4	2	4	1	10

3.9 CUMULITIVE IMPACTS

The proposed development will create roads and increase vehicle traffic on site and in the immediate area. Additional roads and higher traffic volumes are expected to result in increased roadkill incidence for *Sensitive Species 12*. This is in turn expected to result in greater habitat fragmentation. *Sensitive Species 12* is associated with rocky ridges and a greater likelihood of mortality due to roadkill when migrating between these habitats will limit gene-flow and contribute to population isolation. Since the suitable habitats on the proposed development site already represent an isolated habitat patch and is not part of the continuous mountain ranges and rocky ridges that form the core portion of this species' geographic distribution, the contribution of the proposed development to these cumulative effects is considered to be negligible.

4 CONCLUSION

There is a very high likelihood that *Sensitive Species 12* will occur within the study area, in particular on and around the koppie (Figure 4), which has been characterised as High SEI (Figure 7; Table 5). It is unlikely that the proposed mining activities will have a highly significant impact on the species. If appropriate avoidance and minimisation mitigation is applied as discussed above (Table 6), all impacts are expected to be of low significance except that of habitat loss / degradation, which will remain of medium significance due to the unavoidable loss of high SEI habitat which will be caused by the north pit. Appropriate evaluation of impacts has been performed and specific mitigation measures have been discussed. In conclusion, stringent application of the mitigation measures described will result in negligible impacts to *Sensitive Species 12*, but this will also depend on continued monitoring and reporting of these impacts so that adaptive mitigation can be applied where necessary throughout the construction, operation and decommissioning phases. A monitoring plan should therefore be developed as part of the environmental authorisation process which specifically addresses the three major anticipated impacts to *Sensitive Species 12* and ensures compliance with the mitigation measures suggested in Table 6. Furthermore, additional key components required to be included in the monitoring plan are as follows:

1. Habitat loss / destruction: habitat/vegetation monitoring of the High SEI habitats surrounding the mining activities to ensure effectiveness of mitigation measures and allow for adaptive management in cases of non-compliance or additional unforeseen impacts;
2. Roads and roadkill: database of all tortoise observations (including geographic coordinates) to allow for hotspot analysis so that mitigation through movement barriers/diverters and speed restrictions for vehicles can be applied effectively;
3. Collection for food/trade: Following initial induction of staff, regular toolbox talks or updates to reaffirm rules and regulations regarding basic conservation principles and tortoise collection / consumption.

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6 APPENDIX

Appendix 1: Habitat descriptions of herpetofauna sample sites

Sample Site details	Habitat and survey details
V1 23/11/2021 14:36:39	**Habitat Description** Open to moderately dense *Combretum* woodland on stony low hill.

-24.3585473° 28.9476533°	**Survey Conditions** Not fully surveyed, just habitat evaluation **Nocturnal Survey?** No



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V2 23/11/2021 14:44:00 -24.356844° 28.943491°	**Habitat Description** Open mixed woodland savanna. Strong grass element. **Survey Conditions** Not fully surveyed, just habitat evaluation **Nocturnal Survey?** No



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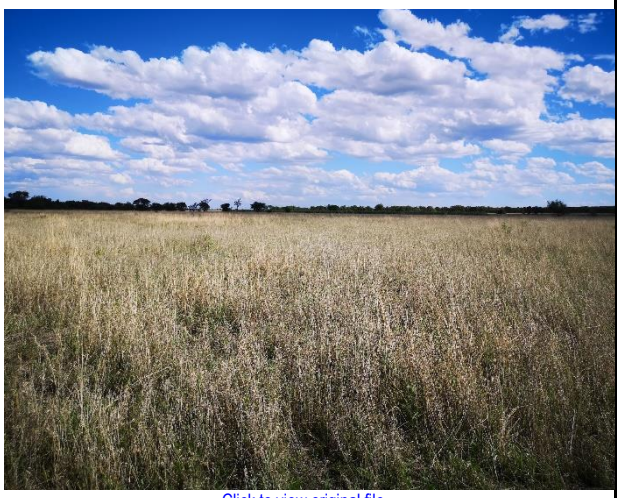
V3 23/11/2021 14:48:22 -24.3567074°	**Habitat Description** Open grassy floodplain (mowed) bordered by reeds (river) and woodland fringe. **Survey Conditions**

28.9402912°	Not fully surveyed, just habitat evaluation. **Nocturnal Survey?** No



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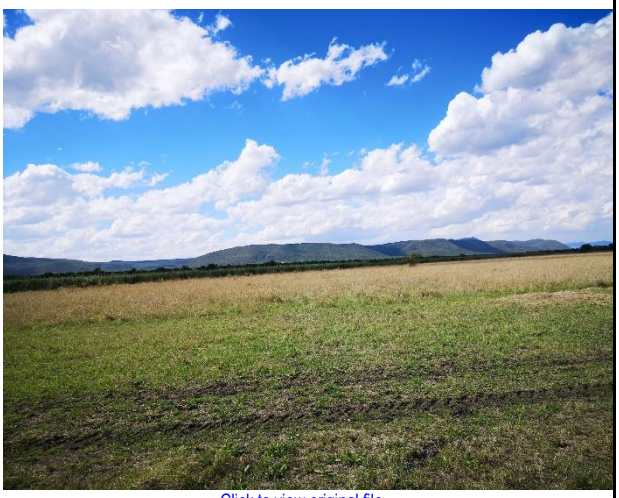

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CROCODILE 4 23/11/2021 14:52:45 -24.3576992° 28.9375545°	**Habitat Description** Recently filled pan in river drainage area. Insufficient to support crocodiles. **Survey Conditions** Cool but not cold, no breeze. Only a single frog species calling **Nocturnal Survey?** Yes



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CROCODILE6 23/11/2021 16:17:05 -24.3467105° 28.9421206°	**Habitat Description** Artificial impoundment in the Nyl River forming only long-term standing water in the area. **Survey Conditions** Warm, slight breeze, dark. Ideal. Relatively low levels of activity. **Nocturnal Survey?** Yes	 Click to view original file
 Click to view original file		 Click to view original file

TORTOISE X1 24/11/2021 08:01:30 -24.3381843° 28.9508836°	**Habitat Description** Mid slope up rocky koppie. Vegetation dominated by *Commiphora*, *Combretum* and *Strychnos*. Semi-open woodland structure, good basal cover. Seemingly ideal for *Sensitive species 12*. **Survey Conditions** Warm and a bit breezy. Near ideal. **Nocturnal Survey?** No	 Click to view original file



Click to view original file



Click to view original file

TORTOISE X2
24/11/2021 09:05:00
-24.3385237°
28.9495639°

Habitat Description
Hillcrest of koppie. Dominated by *Croton* and *Combretum*. Very similar in structure to TORTOISE X1, but on steeper terrain. Seemingly very good *Sensitive species 12* habitat.
Survey Conditions
Warm and a bit breezy. Near ideal.
Nocturnal Survey?
No



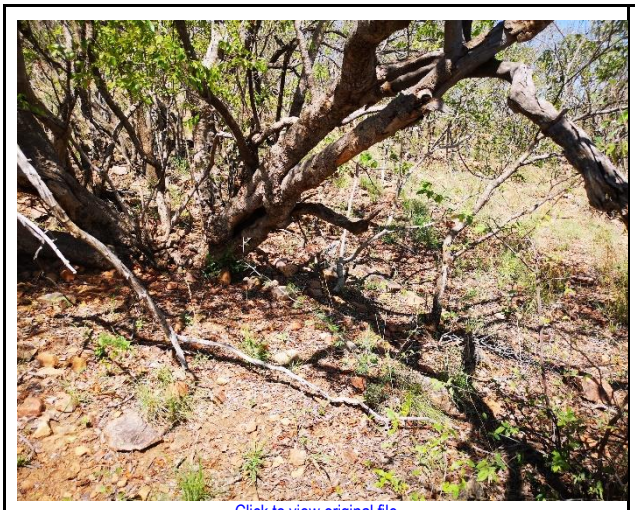
Click to view original file



Click to view original file

TORTOISE X3 24/11/2021 09:20:07 -24.3382067° 28.9491944°	**Habitat Description** Artificially cleared hilltop on koppie. Only grasses and low shrubs. Not suitable for *Sensitive species 12* due to sun exposure from clearing and lack of suitable rocky refugia **Survey Conditions** Warm and a bit breezy. Near ideal. **Nocturnal Survey?** No	 Click to view original file
 Click to view original file		 Click to view original file

TORTOISE X4 24/11/2021 09:42:13 -24.337323° 28.9503774°	**Habitat Description** A continuation of the same habitat described in TORTOISE X1 **Survey Conditions** Warm and a bit breezy. Near ideal. **Nocturnal Survey?** No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TORTOISE X5
24/11/2021 10:14:25
-24.3375275°
28.9513472°

Habitat Description
Rocky footslopes of koppie. Terrain not very steep. Open to semi-closed woodland dominated by *Combretum* and *Vachelia/Senegalia*. Very good basal cover. Seemingly ideal for *Sensitive species 12*.
Survey Conditions
Warm and a bit breezy. Near ideal
Nocturnal Survey?
No


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CROCODILE 3 24/11/2021 11:09:41 -24.332509° 28.9486009°	**Habitat Description** Artificially dammed section of river. Two different waterbodies. Presence of *Cyprus*. Very shallow, not suitable for crocodiles. However, definitely has barbel and at least one other fish species in the upstream pond, indicating near permanence of this waterbody. **Survey Conditions** Cool (but not cold) and quite windy. Frog activity very good, but few species. **Nocturnal Survey?** Yes	 Click to view original file
 Click to view original file		 Click to view original file

TORTOISE X6 24/11/2021 11:41:32 -24.3348571° 28.9541778°	**Habitat Description** Open *Vachelia/Senegalia* woodland savanna. Low density grass cover, poor representation of forbs and succulents. Bare patches of soil common. Not ideally suitable for *Sensitive species 12*. **Survey Conditions** Warm and a bit breezy. Near ideal **Nocturnal Survey?** No

 Click to view original file	 Click to view original file

CROCODILE AD HOC 24/11/2021 21:21:11 -24.313317° 28.9559575°	**Habitat Description** A dam wall across the river that has only a small pool of water. Not suitable for crocodiles. **Survey Conditions** Cool and windy **Nocturnal Survey?** Yes	 Click to view original file

V4 25/11/2021 08:33:30 -24.3637434° 28.9695864°	**Habitat Description** Very homogeneous *Combretum* woodland savanna on stony to rocky ground. Occasional small rocky crests with larger rocks but very scattered and not very large. Suitable habitat for *Sensitive species 12* but not ideal. **Survey Conditions** Warm, slight breezy **Nocturnal Survey?** No


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V5 25/11/2021 08:52:28 -24.3610785° 28.9669576°	**Habitat Description** Very similar to V1 in terms of stony ground: small stones no larger rocks. Open *Combretum* woodland savanna. Very homogeneous. Suitable habitat for *Sensitive species 12* but not ideal. **Survey Conditions** Warm, slight breeze. **Nocturnal Survey?** No


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V6 25/11/2021 09:01:14 -24.3586249° 28.965917°	**Habitat Description** Hillcrest of low hill on either side of the fence. Presence of larger rocks. Sampled into the habitat and although it is rocky, doesn't have large enough boulders to form good refugia for *Sensitive species 12*. No other rupicolus reptiles observed. Suitable habitat for *Sensitive species 12* but not ideal. **Survey Conditions** Warm, slight breeze.

	Nocturnal Survey? No



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V7 25/11/2021 09:35:23 -24.3529851° 28.9595471°	**Habitat Description** *Vachelia* open bushveld savanna on red soils. No rocky substrate. Not ideally suited for *Sensitive species 12*. **Survey Conditions** Warm, slight breeze. **Nocturnal Survey?** No



Click to view original file



Click to view original file

V8 25/11/2021 10:10:52 -24.3225163° 28.9600079°	**Habitat Description** Open *Vachelia* bushveld savanna on red soils. No rocky elements. Very similar to V7 but with more tree diversity perhaps. Not ideally suited for *Sensitive species 12*. **Survey Conditions** Warm, slight breeze. **Nocturnal Survey?**

	No



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V9 25/11/2021 10:26:55 -24.3305372° 28.9933879°	**Habitat Description** Encroached bushveld savanna on red soils. No rocky elements. Not ideally suited for *Sensitive species 12*. **Survey Conditions** Warm, slight breeze. **Nocturnal Survey?** No



Click to view original file



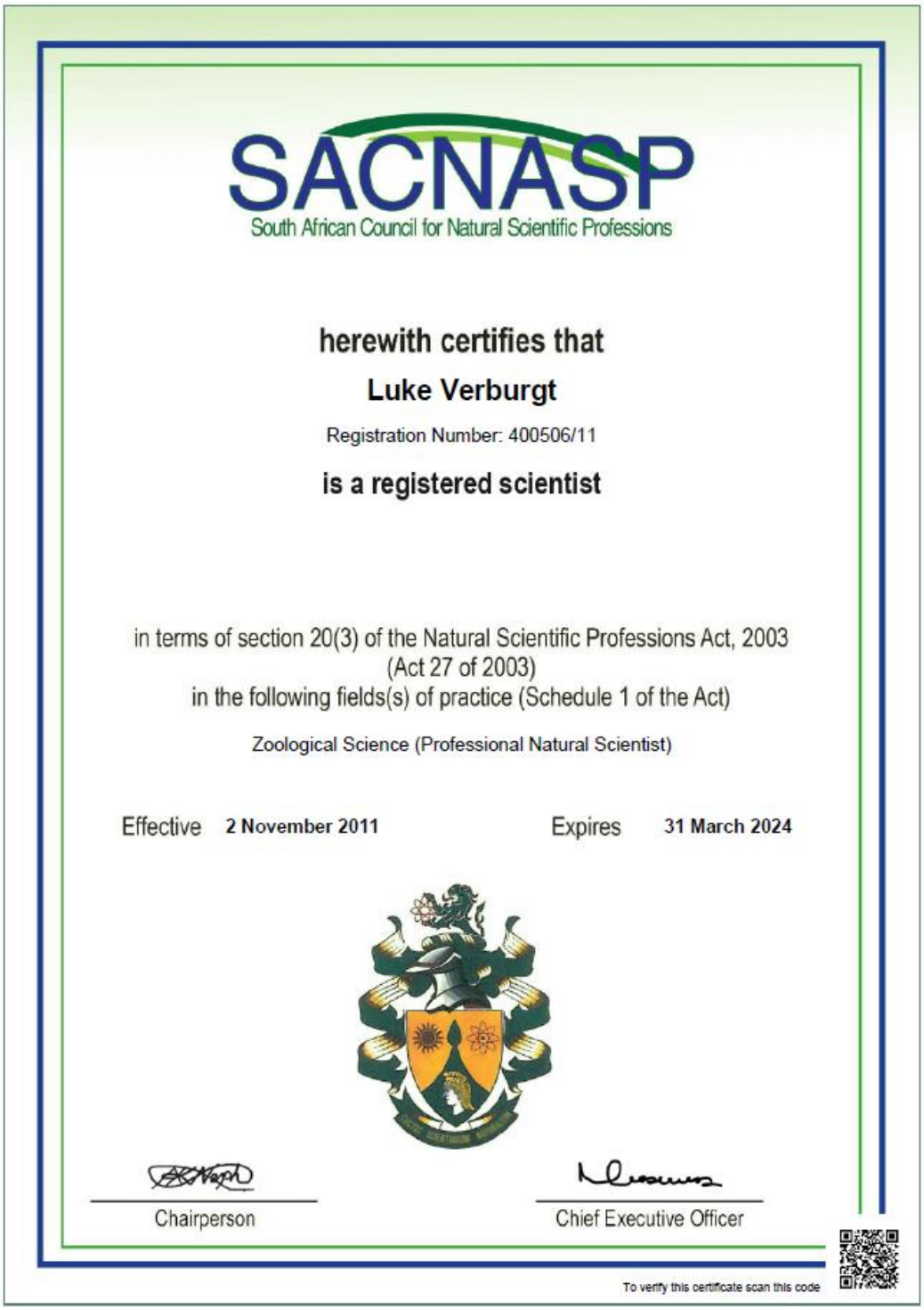
Click to view original file

V10 25/11/2021 10:45:09 -24.3069328° 28.9648672°	**Habitat Description** *Vachelia* and *Dichrostachys* dominated woodland savanna on red soils. No rocky elements. Encroached. Not ideally suited for *Sensitive species 12*. **Survey Conditions** Warm, slight breeze. **Nocturnal Survey?**

	No
 Click to view original file	 Click to view original file

7 QUALIFICATIONS AND CV

SACNASP professional certificate



SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Luke Verburgt

Registration Number: 400506/11

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Zoological Science (Professional Natural Scientist)

Effective **2 November 2011** Expires **31 March 2024**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Enviro INSIGHT
environmental impact assessments

Personal details

Full Name	Luke VERBURGT
DOB	31 March 1977
Nationality	South African
Marital Status	Married
Email	luke@enviro-insight.co.za
Phone	+27 083 784 1997
ID number	770331 5171084

Education

Completed	Degree and Institution
1994	Matric, Pietersburg Hoërskool, Polokwane, South Africa
1999	BSc in Zoology, University of Pretoria, Pretoria, South Africa
2002	BSc (Honours) in Zoology, University of Pretoria, Pretoria, South Africa
2006	MSc in Zoology (Evolutionary Biology, Behaviour, Bioacoustics), University of Pretoria, Pretoria, South Africa.

Memberships & Certificates

SACNASP registration for Zoological Science (member # 400506/11)

Herpetological Association of Africa (HAA)

Other Training

Course in Ecological Niche Modelling, University of Pretoria, 2008

IUCN Workshops: Evaluation of conservation status and protected area analysis for South African Reptiles. SANBI, Cape Town, 2017

Key Biodiversity Areas Workshops: Evaluation of KBA's in Mozambique through the Wildlife Conservation Society and IUCN, 2019

Highlighted relevant experience

17 years of experience performing EIA across 20 countries in Africa.

Lead author of the Guidelines for the application of the Species Protocols during environmental authorisation in South Africa (SANBI 2020)

Member of the species specialist panel for the IUCN Red List assessment of South African Reptiles

Publications & Contributions

Field Guide to the Reptiles of Malawi and Zambia; STRUIK (in production).

SANBI 2020 – Guidelines for the application of the Species Protocols during environmental authorisation in South Africa (in production).

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Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Enviro INSIGHT
environmental impact assessments

Employment & work-related experiences

2009 - present	Co-Director and Co-Owner of Enviro-Insight CC, Ecologist, Lead-Herpetologist and GIS specialist.
2007 - present	Scientific Collaborations, University of Pretoria
2006 - present	Software development, database management, web-design
2005 - present	Co-supervisor, University of Pretoria
2001-2010	Demonstrator and Lecturer, University of Pretoria
1995-1995	Project Assistant, Blouberg Conservation Project

Key areas of expertise

Herpetological Assessments and Survey, Environmental Impact Assessments, Biodiversity and Ecological Assessments, Environmental Management and Monitoring Plans, GIS mapping, Spatial analyses, Software Development, Statistics, Health and Safety Training, Project Management

Language skills

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
Afrikaans	Good	Fair	Basic
Portuguese	Basic	Basic	None
German	Fair	Fair	None
Northern Sotho	Basic	None	None

References

Prof, JWH Ferguson, willemferguson@zoology.up.ac.za

Prof, AE McKechnie, aemckechnie@zoology.up.ac.za

Prof, CT Chimimba, ctchimimba@zoology.up.ac.za

Project Experience

Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

For further details please contact me directly: luke@enviro-insight.co.za

Time span	Nature of project	Capacity	Industry / Sector	Client / Developer	Country (Province)
2020	Herpetofauna Survey & High Conservation Value Assessment	Herpetologist	Forestry / Plantation	HCV Africa / Socapalm	Sao Tome & Principe
2020	Herpetofauna Survey & Environmental Impact Assessment	Herpetologist	Mining / Copper	Managem	Morocco
2020	Mozambique onshore environmental monitoring – palma sand skink Survey	Herpetologist	Oil & Gas	Total / SLR	Mozambique (Cabo Delgado)
2020	Herpetofauna Survey & High Conservation Value Assessment	Herpetologist	Forestry / Plantation	HCV Africa / Socapalm	Cameroon (Douala)
2020	Letseng Monitoring	Herpetologist	Mining / Diamonds	Bathusi / Letseng Diamonds	Lesotho
2019	Herpetofauna Survey & High Conservation Value Assessment	Herpetologist	Forestry / Agriculture	HCV Africa / Socapalm	Ivory Coast (Bas-Sassandra)
2019	Herpetofauna Survey & High Conservation Value Assessment	Herpetologist	Forestry / Agriculture	HCV Africa / Socapalm	Cameroon (Douala)
2019	Herpetofauna Survey & Environmental Impact Assessment (Wet Season Fieldwork)	Herpetologist	Mining / Metals	HCV Africa / Pensana Metals	Angola (Huambo)
2019	Environmental and Social Impact Assessment Report	Senior Specialist	Transport / Rail	ERM / Yapi Merkezi	Tanzania
2019	Herpetofauna Survey	Herpetologist	Forestry / Plantation	Merensky	South Africa (Limpopo)
2019	Rehabilitation Study (Herpetofauna)	Herpetologist	Mining / Coal	EkoInfo / AngloAmerican	South Africa (Mpumalanga)
2018	GIS Least Cost Road Model	GIS Specialist	Mining / Gold	Avesoro	Liberia (Grand Cape Mt)
2018	Environmental Impact Assessment	Herpetologist	Agriculture	Montrose	Angola (Cabinda)
2018	Environmental Impact Assessment	Herpetologist	Agriculture	Montrose	Angola (Huambo)
2018	Environmental Impact Assessment	Herpetologist	Agriculture	Montrose	Angola (Kwanza Sul)
2018	Environmental Impact Assessment	Herpetologist	Agriculture	Montrose	Angola (Lunda Sul)
2018	Mining Application Process / EIA	Herpetologist	Mining / Coal	Insa Coal	South Africa (Gauteng)
2018	Faunal baseline and Impact Assessment	Ecologist & GIS specialist	Transport / Pipeline	Advisian	South Africa (Western Cape)
2018	Monitoring - Sebenza and Prospect	Project Manager	Electricity / Power Stations	Eskom / City Power	South Africa (Gauteng)

2018	GIS Least Cost Road Model	GIS Specialist	Mining / Gold	Avesoro	Liberia (Grand Cape Mt)
2018	Ecological & Ridge Delineation Assessment	Herpetologist & GIS specialist	Development	HES - Henwood Environmental Solutions	South Africa (Gauteng)
2018	Invasive Species Assessment	Herpetologist	Municipality	Sazi / City of Johannesburg	South Africa (Gauteng)
2018	Biodiversity Study (Silver Hills)	Herpetologist	Mining / Gold	Avesoro	Liberia (Grand Cape Mt)
2018	Biodiversity Study (Sarama)	Herpetologist	Mining / Gold	Avesoro	Liberia (Grand Cape Mt)
2018	Mining Application Process / EIA	Herpetologist	Mining / Coal	Insa Coal	South Africa (Gauteng)
2018	Faunal baseline and Impact Assessment	Herpetologist	Transport / Pipeline	Advisian	South Africa (Western Cape)
2018	Behavioral Ecology Research on Snake repellant	Supervisor	Science / Research	University of Pretoria / private	South Africa (Limpopo)
2018	Biodiversity Offset Plan (New Liberty)	Ecologist & GIS Specialist	Mining / Gold	Avesoro	Liberia (Grand Cape Mt)
2018 - 2017	Herpetological Study (Prieska)	Herpetologist	Mining / Copper	Ecorex	South Africa (Northern Cape)
2018 - 2017	Faunal baseline and Impact Assessment (Saldanha)	Ecologist	Transport / Pipeline	Advisian	South Africa (Western Cape)
2018 - 2015	Database & Software Development for Marion Island Marine Mammal Programme	Programmer / Developer	Science / Research	University of Pretoria / Marion Island Marine Mammal Programme	South Africa (Marion Island)
2017	Herpetological Survey (Buffelskloof)	Herpetologist	Science / Research	BKNR / private	South Africa (Mpumalanga)
2017	Environmental Impact Assessment (Koulekoun & Kodiaran)	Herpetologist	Mining / Gold	Ecorex / Tri-K	Guinea (Kankan)
2017	Scoping (Weaju)	Ecologist	Mining / Gold	Aureus / Avesoro	Liberia (Grand Cape Mt)
2017	Herpetofauna Monitoring (Woodbush)	Herpetologist	Forestry / Plantation	Komatiland	South Africa (Limpopo)
2017	Environmental Impact Assessment (Majama Mine)	Herpetologist	Mining / Coal	Geo-Consult International	South Africa (Limpopo)
2017	Basic Assessment Kuruman (Red Sands)	Ecologist	Development / Filling Station	Midturion Information Consultants	South Africa (Northern Cape)
2017	Herpetological Monitoring (Letseng Mine)	Herpetologist	Mining / Diamonds	Riaan / Letseng Diamonds	Lesotho (Mokhotlong District)
2017	Environmental Impact Assessment (Pavua)	Ecologist	Dam / Hydro-electric	TBC / Mott McDonald	Mozambique (Sofala)

2017	Basic Assessment (Knopjeslaagte)	Ecologist	Development	Nali / Mitrajaya Development	South Africa (Limpopo)
2017	Environmental Impact Assessment (Skurvekop)	Herpetologist	Mining / Coal	TBC / Exxaro	South Africa (Mpumalanga)
2017 - 2016	Environmental Impact Assessment (dual season)	Herpetologist	Mining / Gold	Aureus	Liberia (Grand Cape Mt)
2016	Environmental Impact Assessment (Inhassoro)	Herpetologist	Development / Industrial	Sasol / Golder / Mark Wood Consultants	Mozambique(Inhambane)
2016	Walkdown (Zonderwater)	Herpetologist	Mining / Iron Ore	EkoInfo / Exxaro	South Africa (Limpopo)
2016	Environmental Impact Assessment	Herpetologist	Dam / Hydro-electric	Mott MacDonald	Mozambique(Inhambane)
2016	Sasol REIA Ecology	Herpetologist	Oil & Gas / Development	ERM	Mozambique(Inhambane)
2016	Angola - Okavango Wilderness Project (2 expeditions)	Herpetologist	Science / Research	National Geographic	Angola (Moxico)
2016	Rhino Oil& Gas - GIS project	GIS Specialist	Oil & Gas / Development	TBC / Rhino Oil & Gas	South Africa (EC, KZN, MPU, GAU)
2015	Environmental Impact Assessment	Herpetologist	Mining / Uranium & Molybdenum	TBC / Ferret	South Africa (Western & Eastern Cape)
2015	Marion Island site visit for Database & Software Development	Programmer / Developer	Science/Research / Software Development	University of Pretoria / Marion Island Marine Mammal Programme	South Africa (Marion Island)
2015	Environmental Impact Assessment (dual season)	Herpetologist	Mining / Gold	Aureus	Liberia (Grand Cape Mt)
2015	Gap Analysis	Herpetologist	Mining / Gold	Aureus	Liberia (Grand Cape Mt)
2015	Ecological Constraints Mapping	Ecologist	Mining / Oil & Gas	Anadarko	Mozambique (Cabo Delgado)
2015	Critical Habitat Evaluation	Ecologist	Mining / Oil & Gas	Anadarko	Mozambique (Cabo Delgado)
2015	Monitoring - Terrestrial Fauna & Flora	Fauna specialist & Ecologist	Mining / Coal	Golder Associates / Rio Tinto Mozambique	Mozambique (Tete)
2015	Rapid Grassland Assessment	Ecologist	Development	Bokamoso	South Africa
2015	Research Platysaurus lizards	Herpetologist	Research / Taxonomy	n/a	South Africa (Limpopo)
2014	Biodiversity Assessment with EIA	Herpetologist	Transport / Port & Rail	Impacto / Italthai	Mozambique (Zambezia & Tete)
2014	Biodiversity Assessment	Ecologist	Development / Farming	Red Ant	South Africa (Gauteng)

2014	Environmental Impact Assessment - Update & Expansion	Herpetologist	Mining / Oil & Gas	Impacto & RS2 / Anadarko	Mozambique (Cabo Delgado)
2014	Flora & Fauna Biodiversity Assessment	Ecologist		Impacto / Kingho	Mozambique (Tete)
2014	Biodiversity Assessment (dual season)	Herpetologist	Mining / Iron Ore	EkoInfo / Exxaro	South Africa (Limpopo)
2013	Biodiversity Assessment	Herpetologist	Mining / Coal	EkoInfo / Exxaro	South Africa (Mpumalanga)
2013	Flora & Fauna Biodiversity Assessment with EIA	Ecologist	Development / Industrial	Worley Parsons / ArcelorMittal	South Africa (Western Cape)
2013	Biodiversity Assessment	Herpetologist	Mining / Coal	EkoInfo / Coffey Mining	Mozambique (Tete)
2013	Biodiversity Assessment	Herpetologist	Development / Housing	EkoInfo	South Africa (Gauteng)
2013	Environmental Management Plan & Tree marking & Walkdown	Ecologist	Energy / Transmission	Baagi / ESKOM	South Africa (Northern Cape)
2013	Flora & Fauna Biodiversity Assessment with EIA	Herpetologist	Agriculture / Forestry	Impacto / Portucel	Mozambique (Zambezia & Manica)
2013	Bullfrog survey with EIA & recommendations for tailings storage facility	Herpetologist	Mining / Platinum	Prescali	South Africa (North-West)
2013	Flora & Fauna Biodiversity Assessment with EIA	Herpetologist & Mammalogist / Fauna specialist	Agriculture / Sugarcane	Impacto / MAI	Mozambique (Gaza)
2013	Environmental Impact Assessment - Update & Expansion	Herpetologist	Mining / Oil & Gas	Impacto & RS2 / Anadarko	Mozambique (Cabo Delgado)
2013 - 2012	Environmental Impact Assessment (dual season)	Herpetologist	Mining / Iron Ore	ERM / Western Cluster Limited	Liberia (Bomi County or Grand Cape Mt)
2012	Biodiversity Assessment	Herpetologist	Mining / Coal	EkoInfo / Coffey Mining	Mozambique (Tete)
2012	Biodiversity Assessment	Ecologist	Development / Housing	Stefan Frylinck & Associates	South Africa (Mpumalanga)
2012	Flora & Fauna Biodiversity Assessment with dual season EIA	Herpetologist	Mining / Iron Ore	EkoInfo / Exxaro	South Africa (Limpopo)
2012	Biodiversity Assessment (Carolina)	Herpetologist	Mining / Coal	Borent / Exxaro	South Africa (Mpumalanga)
2012	Biodiversity Assessment (New Castle)	Herpetologist	Mining / Coal	Borent / Exxaro	South Africa (Kwa-Zulu Natal)
2012	Flora & Fauna Biodiversity Assessment with dual season EIA	Herpetologist	Mining / Oil & Gas	Impacto & ERM / Anadarko	Mozambique (Cabo Delgado)
2012	Health & Safety Service - Container clearing	Herpetologist	Mining / Oil & Gas	Anadarko	Mozambique (Cabo Delgado)

2012	Environmental Impact Assessment (single season)	Herpetologist	Mining / Infrastructure	ERM / China Union	Liberia (Bong County)
2012	Scoping Assessment	Herpetologist	Mining / Iron Ore	ERM / China Union	Liberia (Bong County)
2012	Environmental Training - Venomous Snakes	Course Presenter	Education & Training	Geo Pollution Technologies	South Africa (Gauteng)
2012	Python Scoping	Herpetologist	Development	Pachnoda	South Africa (Gauteng)
2011	Scoping Assessment for EIA	Herpetologist	Mining / Coal	EkoInfo / Anglo Coal	South Africa (Limpopo)
2011	Environmental Impact Assessment (single season)	Herpetologist	Mining / Iron Ore	Pachnoda / Aquila Steel	South Africa (Limpopo)
2011	Flat Lizard Research project	Herpetologist	Research / Taxonomy	Macquarie University Australia / M. Whiting	South Africa (Limpopo)
2011	Faunal Assessment with dual season EIA	Herpetologist	Mining / Coal	Impacto / Ncondezi	Mozambique (Tete)
2011	Aerial Ecological Survey	Ecologist	Energy / Transmission	Promap / Madagascar Government	Madagascar (Toamasina / Antananarivo)
2011	Flora & Fauna Biodiversity Assessment with EIA	Herpetologist	Mining / Coal	Rural Maintenance / Malawi Government	Malawi (Northern)
2011	Faunal Assessment with EIA	Herpetologist	Hydrology / Water security	Impacto / Moamba Major Damming Project	Mozambique (Maputo)
2011	Flora & Fauna Biodiversity Assessment with EIA	Fauna specialist & Ecologist	Mining / Coal	Impacto / Jindal	Mozambique (Tete)
2011	Flora & Fauna Biodiversity Assessment with dual season EIA	Herpetologist	Mining / Oil & Gas	Impacto & ERM / Anadarko	Mozambique (Cabo Delgado)
2011	Flora & Fauna Biodiversity Assessment - dual season EIA	Herpetologist	Mining / Coal	EkoInfo	South Africa (Mpumalanga)
2011	Site Selection Assessment & Scoping	Ecologist	Mining / Oil & Gas	Impacto & ERM / Anadarko	Mozambique (Cabo Delgado)
2011	Flora & Fauna Biodiversity Assessment - dual season EIA	Herpetologist	Mining / Coal	EkoInfo	South Africa (Mpumalanga)
2011 - 2010	Environmental Training - Dangerous Game & Venomous Snakes	Course Presenter	Energy / Education & Training	Endangered Wildlife Trust (EWT) / ESKOM	South Africa (Throughout)
2011 - 2010	Flora & Fauna Biodiversity Assessment (dual season)	Herpetologist	Energy / Hydroelectricity	Impacto / Mozambique Government	Mozambique (Tete)
2010	Python Scoping & Vegetation Functionality	Herpetologist	Agriculture / Livestock	AGES	South Africa (Gauteng)
2010	Python Scoping	Herpetologist	Development / Housing	AGES	South Africa (Gauteng)

2010	Health & Safety Service - Snake removal	Herpetologist	Energy / Health & Safety	ESKOM	South Africa (Gauteng)
2010	Monitoring	Assistant Mammalogist	Mining / Coal	Impacto / VALE	Mozambique (Tete)
2010	Monitoring	Herpetologist	Research / Biodiversity	University of Pretoria / CEFS	South Africa (Gauteng)
2010	Flora & Fauna Biodiversity Assessment with EIA	Herpetologist	Energy / Hydroelectricity	Rural Maintenance / Malawi Government	Malawi (Northern)
2009	Herpetofauna bio-survey on Dronfield, Benfontein & Rooipoort	Herpetologist	Development / Conservation	De Beers	South Africa (Northern Cape)
2009	Python Scoping	Herpetologist	Development / Agriculture	EkoInfo	South Africa (Gauteng)
2008	Herpetofauna bio-survey on Tswalu Kalahari Reserve	Herpetologist	Development / Conservation	De Beers	South Africa (Northern Cape)
2007	Herpetology Specialist Study	Herpetologist	Mining / Coal	Ferret & Environmental Services / Borent	South Africa (Western & Eastern Cape)
2007	Herpetology Specialist Study	Herpetologist	Mining / Coal	Ferret & Environmental Services / Borent	South Africa (Mpumalanga)
2007	Herpetology Specialist Study	Herpetologist	Mining / Coal	Ferret & Environmental Services / Borent	South Africa (Mpumalanga)
2007	Herpetology Specialist Study	Herpetologist	Mining / Coal	Ferret & Environmental Services / Borent	South Africa (Mpumalanga)
2007	Herpetology Specialist Study	Herpetologist	Mining / Coal	Ferret Mining & Environmental Services / Borent	South Africa (Gauteng)
2006	Herpetology Specialist Study	Herpetologist	Mining / Uranium	Ferret & Environmental Services / Borent	South Africa (Mpumalanga)
2003	Herpetology Specialist Study	Herpetologist	Development / Housing	EcoCheck / Environmental Services and Art	South Africa (Gauteng)