APPENDIX M: PALAEONTOLOGICAL IMPACT ASSESSMENT

Palaeontological Impact Assessment for the proposed Amendment for Mokala Manganese Mine, Hotazel, Northern Cape Province

Desktop Study

For

HCAC

28 May 2021

Prof Marion Bamford
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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Heritage Contracts and Archaeological Contracts, Modimolle, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the proposed amendment to the surface mining infrastructure for Mokala Manganese Mine (Pty) Ltd approximately 4 km northwest of Hotazel, Northern Cape Province (SAHRA Case ID:16262). To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed changes to the mine and infrastructure, on Farm Gloria 266, and borders of Farms Kipling 271 and Umtu 281, all lie on the Quaternary Kalahari Group aeolian sands, alluvium and calcrete and a small portion of surface limestone. There is a very small chance that fossils may occur in palaeo-pans or palaeo-springs BUT no such feature is visible. The area is already highly disturbed from current mining operations. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once the surveyor and/or the environmental officer have checked the sites for the planned facilities, the fossils should be photographed, their position recorded, then removed and stored. Photographs sent to the palaeontologist will enable him/her to assess the scientific importance of the fossils and act accordingly.

The Impact Significance:

SIGNIFICANCE – PRE-MITIGATION	SIGNIFICANCE – POST-MITIGATION
Low	Very Low
Unlikely that it will have a real influence on the decision. Limited mitigation is likely required	It will not have an influence on the decision. Does not require any mitigation
Fossils remain	Fossils removed

Table of Contents

1. Background

Mokala Manganese (Pty) Ltd (Mokala) has received authorisation to establish the Mokala Mine that is located on the remaining extent and portion 1 of the farm Gloria 266, the farm Kipling 271 and the farm Umtu 281, approximately 4 km northwest of the town Hotazel in the Joe Morolong Local Municipality, in the Northern Cape Province. Mokala Manganese (Pty) Ltd SLR Project No: 720.09012.00010

The Mokala Mine is an open cast manganese mine with approved infrastructure components comprised of a dry crushing and screening plant; WRDs, Run-of- Mine (ROM) stockpiles; topsoil stockpiles; water storage facilities; stormwater management infrastructure and mine-related support facilities such as workshops, stores, and offices. Additional approved activities include:

- the realignment of the R380 road on the farm Kipling 271 and across the remaining extent of the farm of Gloria 266;
- upgrading of the intersection to the mine on portion 1 of the farm Gloria 266 also serving the existing Gloria Mine;
- the realignment of a section of the Ga-Mogara drainage channel within the existing river channel. This realignment extends onto the farm Umtu 281.

The Mokala Mine is currently in the construction and operational phase of the project. In this regard, temporary infrastructure in support of the construction phase is currently on site. Construction facilities will either be removed at the end of the construction phase or incorporated into the layout of the operational mine. The mine has also begun with their open cast strip mining activities.

Mokala is now proposing to amend the approved mine layout to optimize their mining operations. Changes to the approved infrastructure layout that have already taken place include:

- the reconfiguration of the plant area, ROM, and high-grade product stockpiles to accommodate the expansion of the open pit;
- the relocation of the low-grade product stockpile;
- the relocation of support infrastructure (water storage facilities (potable and process water), workshops and washbay, change houses, sewage treatment plant, water treatment plant, fuel storage, Administrative block (offices, kitchen, canteen, training centre, mustering centre, clinic), stores and waste storage);
- relocation of transportation related facilities/infrastructure (internal haul road, weighbridges, parking areas, truck loading and staging facility);
- the relocation of the approved WRD to accommodate the expansion of the open pit; and
- the relocation of the approved topsoil stockpiles.

Proposed activity/infrastructure changes to the approved surface layout include:

- the proposed expansion of the open pit;
- the proposed increase in the capacity of the approved Waste Rock Dump (WRD) and the establishment of an additional WRD;

- the proposed establishment of addition topsoil stockpiles;
- the proposed relocation of stormwater management infrastructure;
- the proposed increase in the capacity of product stockpiles ROM, Low Grade and High Grade); and
- the proposed mining of the barrier pillar between the Kalagadi Mine and Mokala Mine.

No changes are anticipated to the realignment of the R380, the realignment of the Ga-Mogara drainage channel and the intersection to the entrance of the mine.

A Palaeontological Impact Assessment was requested for the proposed amendment for Mokala Manganese Mine. In order to comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2, Appendix C
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
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;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5

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	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
nii	If the opinion is that the proposed activity 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	N/A
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	Section 8

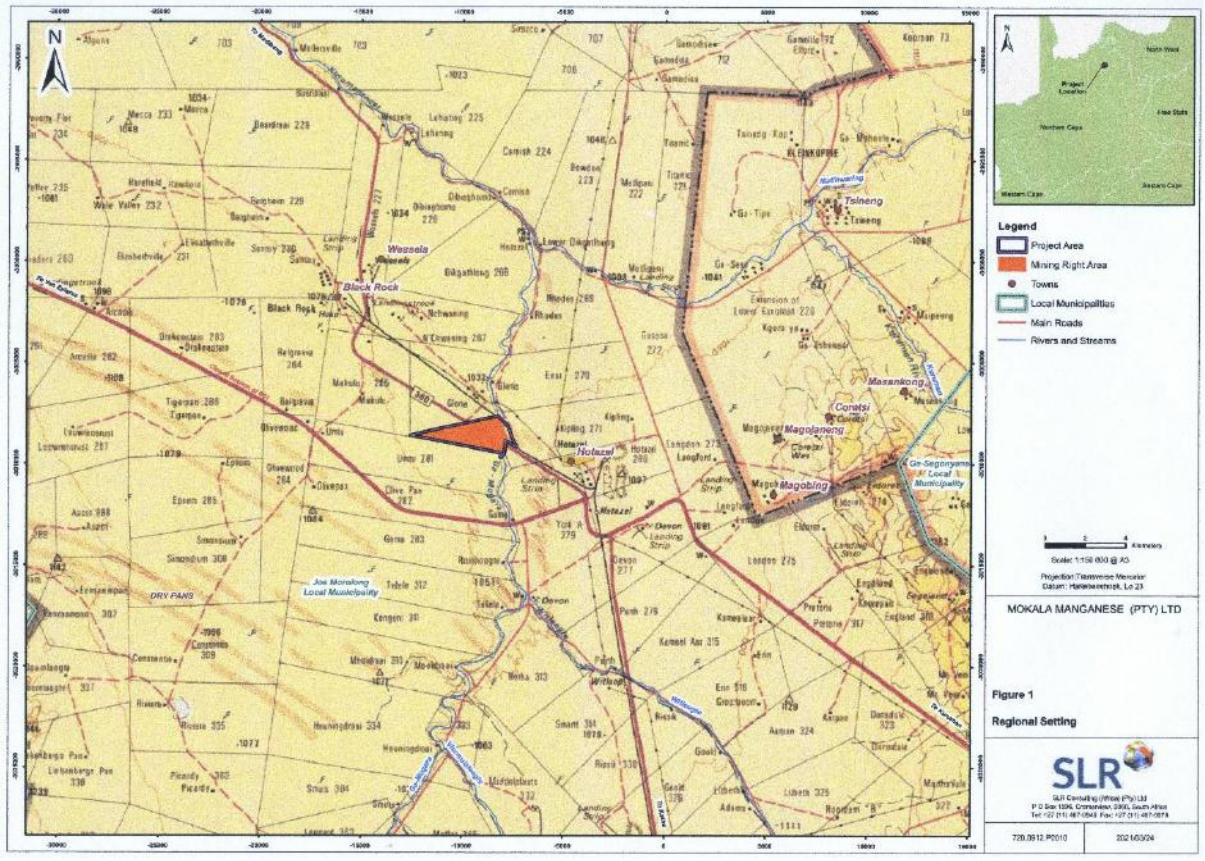

Figure 1: Topographic regional map showing the Mokala Manganese Mine in orange.

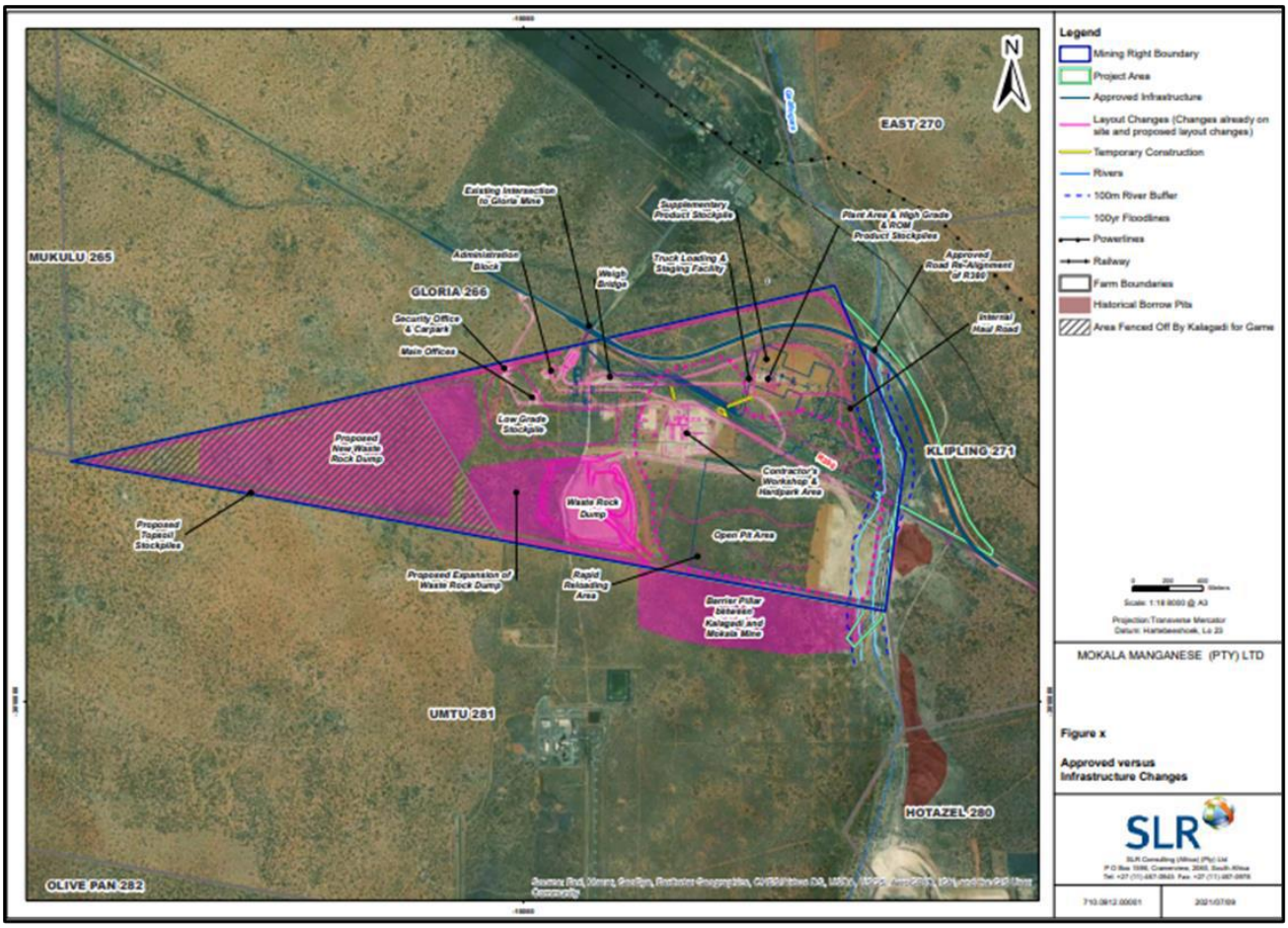

Figure 2: Google Earth map of the proposed amendment to the surface infrastructure on Mokala, northwest of Hotazel, Northern Cape Province. Map supplied by HCAC.

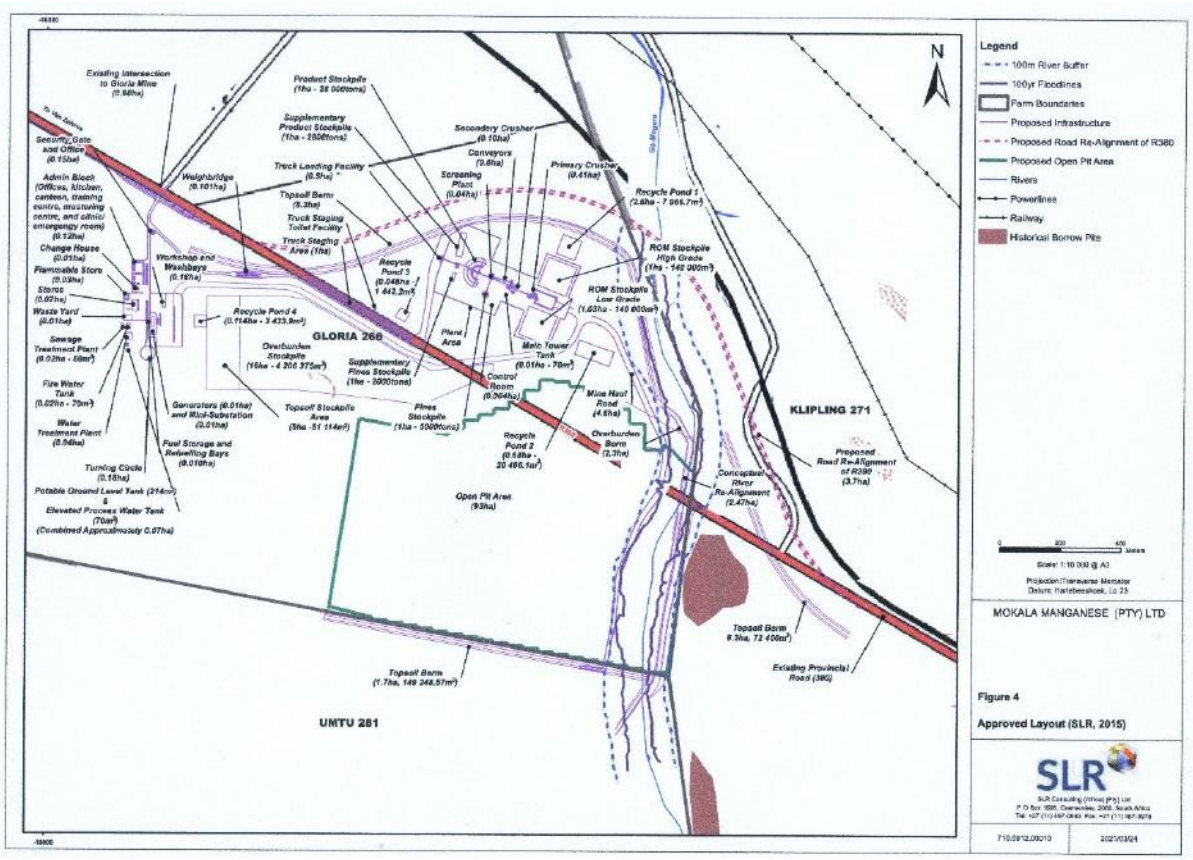

Figure 3: Map showing the approved mine layout from 2015 (SLR Fig 4).

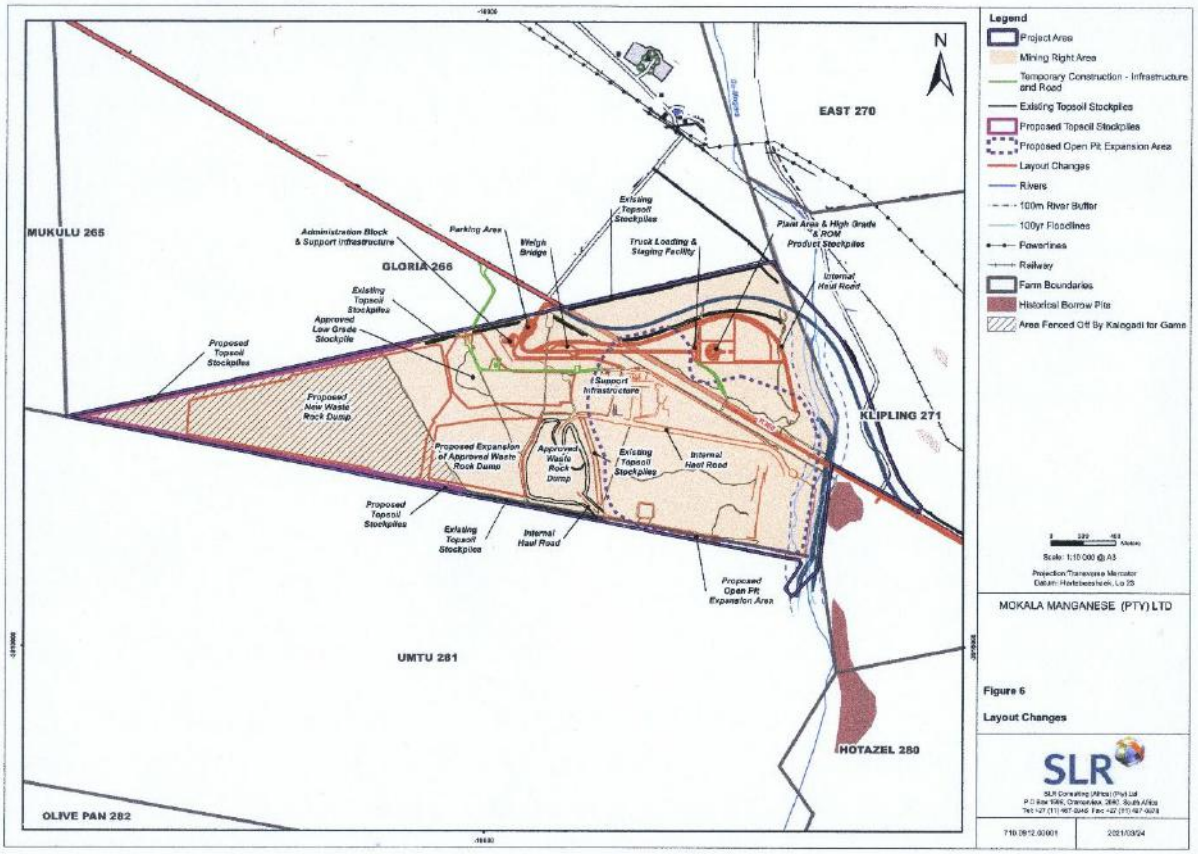

Figure 4: Map showing the planned Layout Changes (from SLR, 2021, Fig 6).

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

In the Griqualand West Basin, the Ghaap Group of the Transvaal Supergroup, is divided into four subgroups, from the oldest, Schmidtsdrift, Campbell Rand, Asbestos Hills and Koegas Subgroups (Eriksson et al., 2006, p. 244). The Koegas Subgroup is overlain by the Postmasburg Group and the latter is divided into the lower Makganyene Formation and the Ongeluk Formation (ibid). There are three formations in the Asbestos Hills Subgroup, from the base, the Kliphuis, Kuruman and Danielskuil Formations, with all three composed of iron-formation. The Asbestos Hills Subgroup is dated at about 2500 Ma (Eriksson et al., 2006; Schroder et al., 2016).

The Campbell Rand Subgroup has nine Formations (Eriksson et al., 2006; Beukes et al., 2016) and they form a stromatolitic carbonate platform. The Campbell Rand Subgroup occurs around the basin margin on the craton. Platform margin and lagoonal dolomites are manganese-rich, whereas basinal dolomites are iron-rich, and intertidal to supratidal deposits are virtually free of iron and manganese (Beukes, 1987). Mokala Manganese Mine on farms Gloria 266 and Kipling 271 is on the Main Kalahari Manganese Deposit (Figures 3, 4).

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common. Some areas of surface limestone also occur.

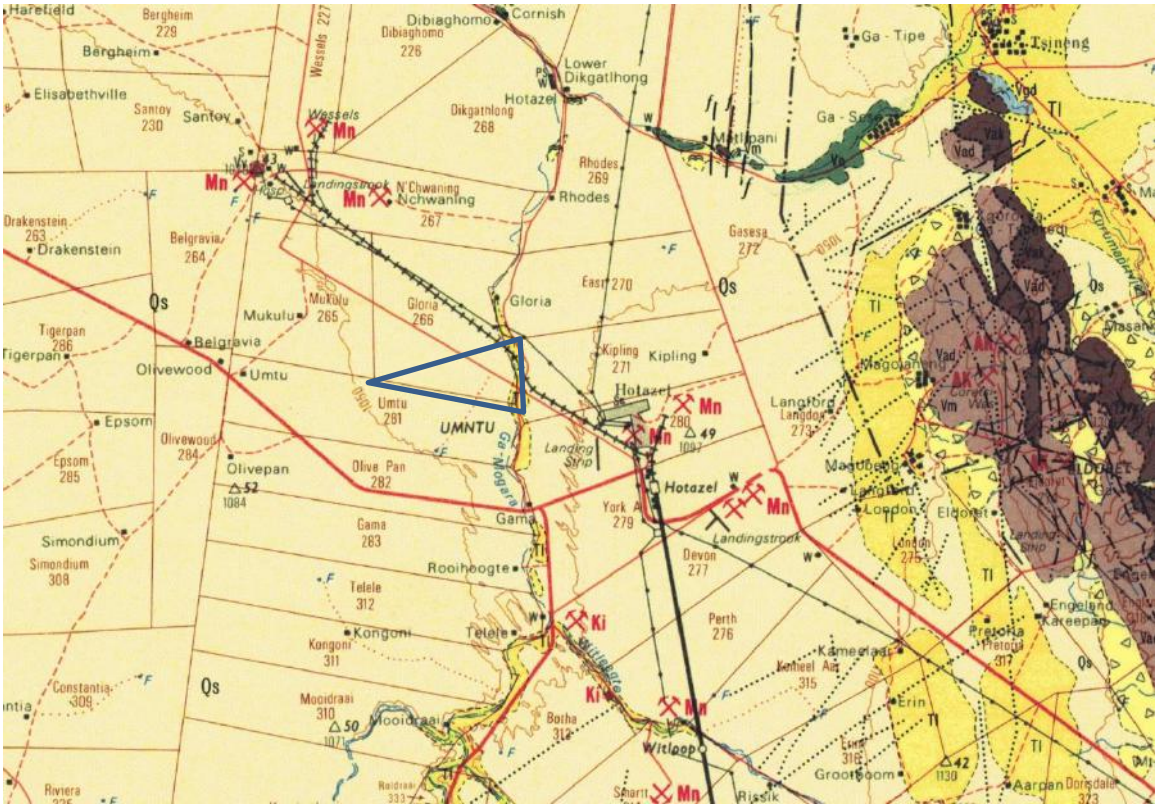

Figure 5: Geological map of the area around Hotazel and Mokala Manganese Mine. The location of the proposed project is indicated within the blue triangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 2722 Kuruman.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; Schroder et al., 2016). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Kalahari Group	Alluvial and aeolian sands	Last ca 2.5 Ma
Tl	Kalahari Group	Calcrete, surface limestone, alluvium	Last ca 2.5 Ma
Vad	Danielskuil Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Banded or massive jaspillite with corcidilite	Ca 2521 – 2440 Ma
Vak	Kuruman Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Banded ironstone with subordinate amphibolite	Ca 2521 – 2440 Ma

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 6. The site of the Mokala Mine is predominantly on alluvium and on aeolian Kalahari sands that were derived from farther to the northwest (Goudie and Wells, 1995), and finally deposited

in this region during the Quaternary. Since they are windblown the sands are not in primary context, nor do they preserve any fossils. There is also an exposure of Quaternary surface limestone down the eastern margin of the mine area. Beneath the surface sands are the manganese deposits that are not fossiliferous.

Fossils can only be preserved if there are spring or palaeo-pan deposits where wood, plants or bones can be entrapped and preserved in the calcrete or silcrete that occasionally forms in such settings. No such deposits have been recorded from this site, and the Google Earth imagery does not show any pan or spring deposits. According to Goudie and Wells (1995) three factors are required for the formation of pans, namely a setting where the fluvial system is not fully integrated, salt weathering and aeolian deflation occur. The latter two conditions apply to this environmental setting, but the first does not as the site is on a slope. Therefore, it is extremely unlikely that there are any pans in the site or any fossils in the sands.

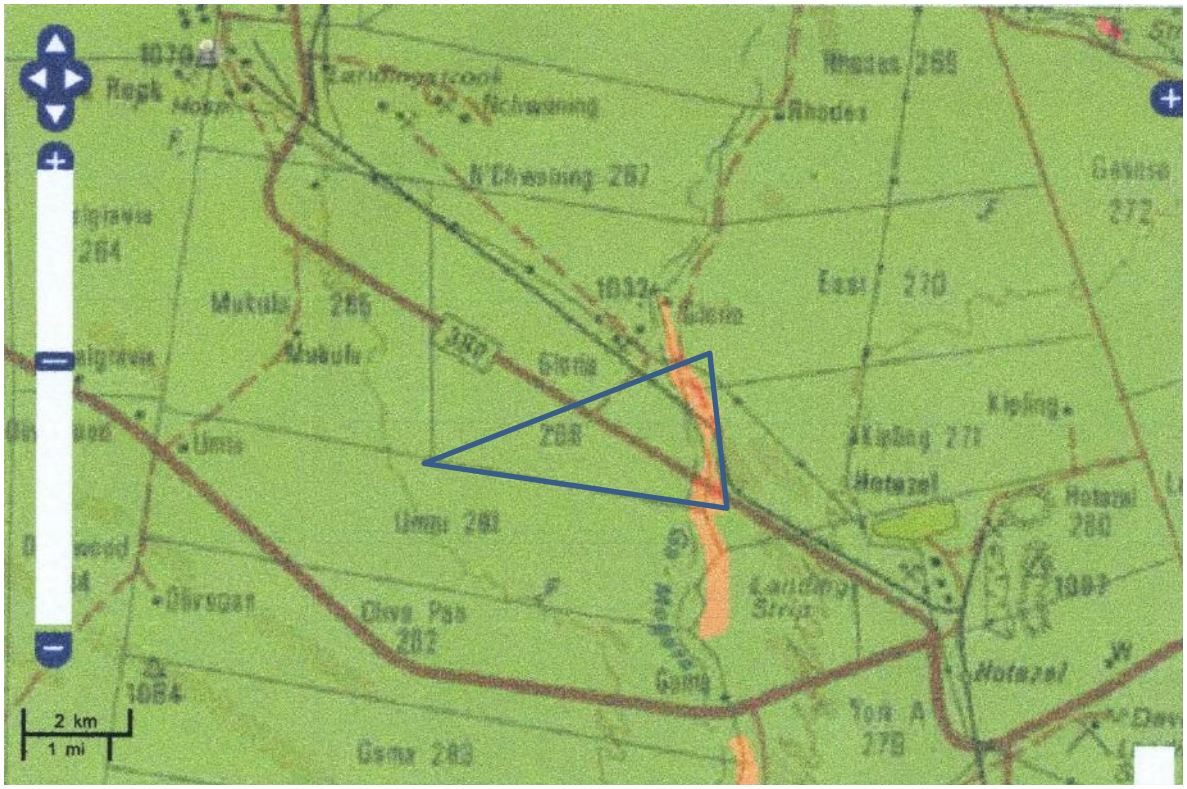

Figure 6: SAHRIS palaeosensitivity maps for the site for the proposed Amendment for Mokala Manganese Mine project shown within the blue rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Plio-Pleistocene fossils have been recovered from palaeo-pans in the region, for example Kathu Pan and Townlands (Walker et al., 2017,) but there are no pans evident in the project footprint. There are palaeontological and archaeological sites in the Kuruman Hills, Ghaap Group, but not in the project footprint.

From the SAHRIS map above the area is indicated as moderately sensitive (green) and highly sensitive (orange) on the eastern margin so a desktop study is presented here.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in the table provided by the EIA company (SLR table in Appendix C).

Table 3: Palaeontological impacts for Planning and Construction Phase = Pre-mitigation and Operation and Closure phases = Post-mitigation.

Assessments for Palaeontology	Pre-mitigation	Post mitigation
Intensity	L+	H+
Duration	VH	VL
Extent	VL	VL
Consequence (Intensity-Duration-Extent)	Med	Low
Probability	L	L
Significance = consequence x probability	Low	Very Low
MITIGATION = removal of any fossils found in the planning stage. If the surveyor, environmental officer sees any fossils in the project area that could be damaged, the position of the fossils should be marked with GPS points, the fossils photographed and then removed to a safe storage site until a palaeontologist can assess their scientific worth. Fossils should be given to a recognised repository (e.g. the McGregor Museum in Kimberley) with the relevant site data.		

PART D: INTERPRETATION OF SIGNIFICANCE

SIGNIFICANCE – PRE-MITIGATION	SIGNIFICANCE – POST-MITIGATION
Low	Very Low
Unlikely that it will have a real influence on the decision. Limited mitigation is likely required	It will not have an influence on the decision. Does not require any mitigation
Fossils remain	Fossils removed

There will be no impact for the operational and closure (decommissioning) phases.
No monitoring is required if there are no fossils or if the fossils have been rescued.

The Consequence of the palaeontological impact during the planning phase and before mitigation (removal of fossils) will be medium if fossils are present and not removed; the consequence will be low if fossils are absent or have been removed.
The extent of the impact is low because only fossils in the mine and infrastructure footprint could be affected.
The duration of the impact would be permanent if fossils are not removed, but is low if they are removed.
The probability of any fossils occurring in the project area is very low because there are no palaeo-pans or palaeo-springs visible on the satellite imagery.

The intensity of the impact is only local.
Significance of the impact is low pre-mitigation and very low post-mitigation.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the aeolian sands, sandstones, calcrete and surface limestone are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. No palaeo-pans or palaeo-springs that could entrap fossils, are visible in the satellite imagery, therefore it is extremely unlikely that they occur in the mine and infrastructure footprint.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils in the aeolian sands, calcretes or surface limestone of the Quaternary. There is a very small chance that fossils may occur in palaeo-pans BUT no such feature is visible. Therefore, a Fossil Chance Find Protocol should be added to the EMPr (see section 8). If fossils are found once the surveyor and/or the environmental officer walks the area, they should be photographed, position recorded, removed and stored. Photographs sent to the palaeontologist will enable him/her to assess the scientific importance of the fossils and act accordingly.

7. References

Beukes, N.J., 1987. Facies relations, depositional environments, and diagenesis in a major early Proterozoic stromatolitic carbonate platform to basinal sequence, Campbell Rand Subgroup, Transvaal Supergroup, southern Africa. Sedimentary Geology 54, 1-46.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 237-260.

Goudie, A.S., Wells, G.L., 1995. The nature, distribution and formation of pans in arid zones. Earth Science Reviews 38, 1–69.

Porat, N., Chazan, m., Grün, R., Aubert, M., Eisenmann, V., Kolska Horwitz, L., 2010. New radiometric ages for the Fauresmith industry from Kathu Pan, southern Africa: Implications for the Earlier to Middle Stone Age transition, Journal of Archaeological Science 37, 269–283.

Schröder, S., Beukes, N.J., Armstrong, R.A., 2016. Detrital zircon constraints on the tectonostratigraphy of the Paleoproterozoic Pretoria Group, South Africa. Precambrian Research 278, 362 – 393.

Walker, S.J.H., Lukich, V., Chazan, M., 2014. Kathu Townlands: A High Density Earlier Stone Age Locality in the Interior of South Africa. PLoS ONE 9(7): e103436. doi:10.1371/journal.pone.0103436

8. Chance Find Protocol

Programme for Palaeontology – to commence once the area is surveyed by the surveyor or environmental officer. Planning/pre-construction phase

1. The following procedure is only required if fossils are seen on the surface when surveyed and any palaeo-pan or palaeo-spring feature is recognised.
2. If any fossiliferous material (plants, insects, bone) is seen it should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figures 7-9). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any scientifically important fossil material as assessed from the submitted photographs, then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the site and excavate (having obtained a SAHRA permit).
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study.
7. Annual reports must be submitted to SAHRA as required by the relevant permits.
8. If no good fossil material is recovered then the site inspection by the palaeontologist will not be necessary.
9. If no fossils are found during the survey then no further palaeontological impact assessment is required.

Appendix A – Examples of a palaeo-pan and fossils

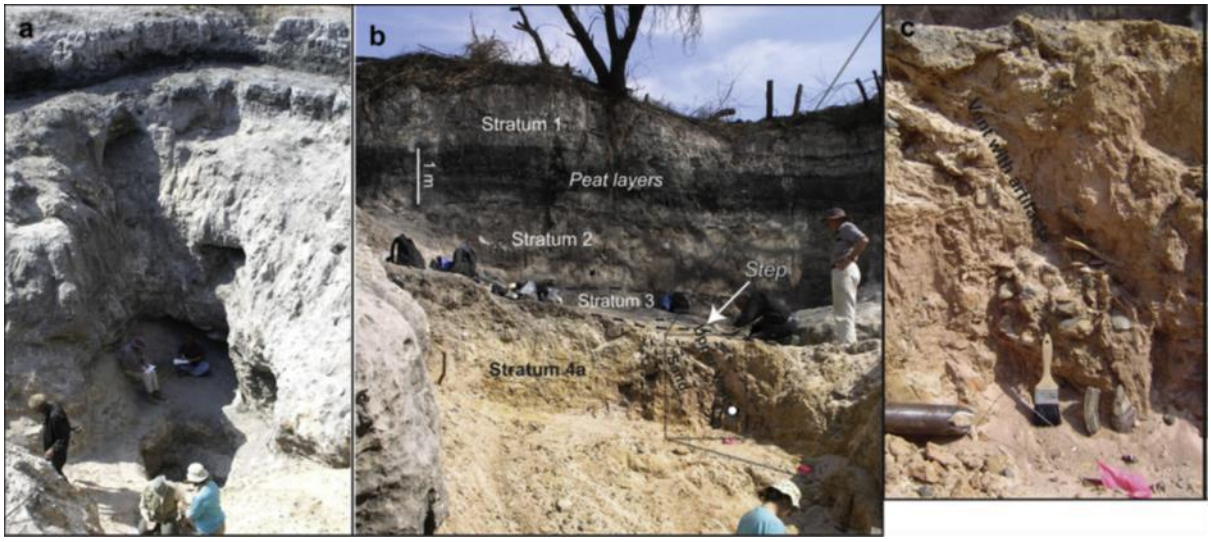

Figure 7: Example of a palaeo-pan deposit, Kathu Pan, near Kuruman and Kathu. From Porat et al., (2010).

Figure 8: Examples of bone fragments from quaternary sediments and could be found associated with pans.

Figure 9: Examples of silicified wood from Pleistocene sediments.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2021

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	11	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year

Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018

- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for Enviropro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for Enviropro

xi) Research Output

Publications by M K Bamford up to January 2021 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 36; -i10-index = 80
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)

Appendix C – SLR Assessment Table

Note: Part A provides the definition for determining impact consequence (combining intensity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

PART A: DEFINITIONS AND CRITERIA*	
Definition of SIGNIFICANCE	Significance = consequence x probability

Definition of CONSEQUENCE		Consequence is a function of intensity, spatial extent and duration
Criteria for ranking of the INTENSITY of environmental impacts	VH	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	VL	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years (likely to cease at the end of the operational life of activity).
	VH	Very long, permanent, +20 years (Irreversible, Beyond closure).
	VL	A part of the site/property.

Criteria for ranking the EXTENT of impacts	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours.
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
INTENSITY = VL							
DURATION	Very long	**VH**	**Low**	**Low**	**Medium**	**Medium**	**High**
	Long term	**H**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Medium term	**M**	**Very Low**	**Low**	**Low**	**Low**	**Medium**
	Short term	**L**	**Very low**	**Very Low**	**Low**	**Low**	**Low**
	Very short	**VL**	**Very low**	**Very Low**	**Very Low**	**Low**	**Low**
INTENSITY = L							
DURATION	Very long	**VH**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Long term	**H**	**Low**	**Medium**	**Medium**	**Medium**	**High**
	Medium term	**M**	**Low**	**Low**	**Medium**	**Medium**	**Medium**
	Short term	**L**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Very short	**VL**	**Very low**	**Low**	**Low**	**Low**	**Medium**
INTENSITY = M							
DURATION	Very long	**VH**	**Medium**	**High**	**High**	**High**	**Very High**
	Long term	**H**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**	**Medium**	**High**
	Very short	**VL**	**Low**	**Low**	**Low**	**Medium**	**Medium**
INTENSITY = H							
DURATION	Very long	**VH**	**High**	**High**	**High**	**Very High**	**Very High**
	Long term	**H**	**Medium**	**High**	**High**	**High**	**Very High**
	Medium term	**M**	**Medium**	**Medium**	**High**	**High**	**High**
	Short term	**L**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Very short	**VL**	**Low**	**Medium**	**Medium**	**Medium**	**High**
INTENSITY = VH							
DURATION	Very long	**VH**	**High**	**High**	**Very High**	**Very High**	**Very High**
	Long term	**H**	**High**	**High**	**High**	**Very High**	**Very High**
	Medium term	**M**	**Medium**	**High**	**High**	**High**	**Very High**
	Short term	**L**	**Medium**	**Medium**	**High**	**High**	**High**
	Very short	**VL**	**Low**	**Medium**	**Medium**	**High**	**High**

VL	**L**	**M**	**H**	**VH**
A part of the site/ property	Whole site	Beyond the site, affecting	Extending far beyond	Regional/ National

		neighbours	site but localised	
EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Medium**	**Medium**	**High**	**Very High**	**Very High**
	Probable	**H**	**Low**	**Medium**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Low**	**Low**	**Medium**	**Medium**	**High**
	Conceivable	**L**	**Very Low**	**Low**	**Low**	**Medium**	**Medium**
	Unlikely/ improbable	**VL**	**Negligible**	**Very Low**	**Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VVH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Negligible	Inconsequential, not requiring any consideration.

***VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact**