

**Palaeontological Impact Assessment for the proposed
Magatle Filling Station and Shopping Centre,
Zebediela,
Limpopo Province**

Desktop Study

For

HCAC

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 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 Consulting, 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 construction of a fuel filling station and shopping centre at Magatle, on Part of the Farm Zebedielas Location 123 KS, Limpopo Province. 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 site lies entirely on the sandstone and aeolian sands of the Clarens Formation, in the northernmost part of the Karoo-aged Springbok Flats Basin. It is extremely unlikely that any fossils would be preserved in the soils and loose sands of the Clarens Formation. There is a very small chance that fossils of dinosaur bones or silicified wood may occur below ground so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found once excavations for foundations, fuel storage tanks and associated infrastructure has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

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1. Background

Executive Petroleum appointed Lokisa Environmental Consulting CC to obtain authorisation from the Limpopo Department of Economic Development, Environment and Tourism (LEDET) for the proposed development of a Filling Station to accommodate 499m³ of fuel on site and a Shopping Centre on a Part of the Farm Zebedielas Location 123 KS.

The Basic Assessment (BA) procedure will apply to this application. The process is done in terms of Government Notice Regulations (GNR) No. 982, 983 and 985 of the EIA Regulations of 2014 (as amended 2017). The EIA Regulations were promulgated in terms of the National Environmental Management Act ('NEMA', Act No. 107 of 1998, as amended).

Location

The site is situated approximately 15km to the south of the R518 Road, 13km north west of the R579 Road, 5.6km north of Molapo Village and directly opposite the Magatle Police Station, Magatle, Limpopo Province. The Nkumpi River, a tributary of the Olifants River, is situated approximately 300m to the east of the site within the jurisdiction of the Lepelle-Nkumpi Local Municipality.

In order 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 project 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
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	Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Appendix A
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.	N/A
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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*).



Figure 1: Google Earth map of the proposed development of a fuel filling station and shopping centre at Magatle, Limpopo Province, with the section shown by the blue outline. Map supplied by HCAC.

3. Geology and Palaeontology

i. Project location and geological context

The site is on the northern margin of the Springbok Flats Basin, an outlier of the Main Karoo Basin, and adjacent to the Bushveld Complex that is of major economic importance with the reserves of platinum group elements. The Rustenburg Layered Suite (Figure 2) is part of the enormous mafic layered intrusion called the Bushveld Complex. According to Cawthorn et al. (2006), it has four parts, the basal Rooiberg Group, overlying Rustenburg Layered Suite, Rashedoop Granophyre Suite and the top Lebowa Granite Suite. These rocks are all of volcanic and are intrusive so do not preserve fossils. They will not be discussed further.

The Springbok Flats Basin does not preserve all the Main Karoo Basin sediments, but has the basal Dwyka Group, Hammanskraal Formation (equivalent to the Ecca Group's Pietermaritzburg and Vryheid Formations), no Beaufort rocks, the Irrigasie Formation (equivalent to the Molteno and Elliot Formations), and the Clarens Formation (Johnson et al., 2006). In the Springbok Flats Basin the Clarens Formation comprises fine-grained, well sorted massive or cross-bedded quartzose sandstone that is pink to cream in colour and frequently mottled (ibid, p. 487).

The project lies entirely on the Clarens Formation (Figure 2).

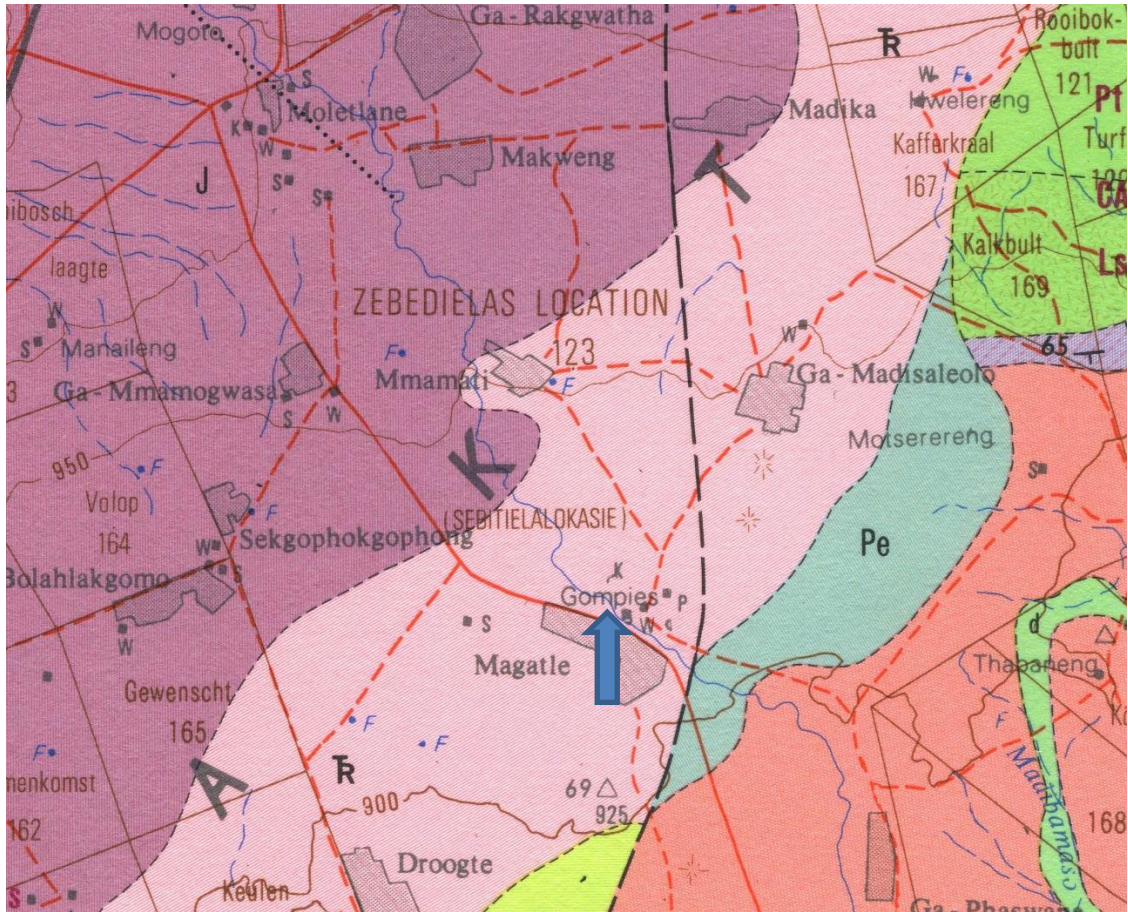


Figure 2: Geological map of the area around Zebediellas and Magatle, Limpopo Province. The location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 2428 Map Nylstroom, 1978.

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

Symbol	Group/Formation	Lithology	Approximate Age
J	Letaba Fm, Karoo SG	Volcanic rocks, sandstone	Jurassic ca 180 Ma
Tr	Clarens Fm, Stormberg Group, Karoo SG	Fine-grained red to cream sandstone	Triassic ca 200 Ma
P-Tr	Irrigasie Fm, Springbok Flats Basin, Karoo SG	Sandstone, grit, mudstone, siltstone, marl, shale	Late Permian or early Triassic
Pe	Ecca Group, Karoo SG	Siltstone, sandstone, shale	Early Permian ca 290-230Ma
Mn	Nebo Granite, Lebowa Granite Suite, Bushveld Complex	Coarse-grained grey to pink granite	>2050 Ma
Vg	Rustenburg Layered Suite, Main Zone, Bushveld Complex	Gabbro, norite, anorthosite	>2050 Ma

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for development is in the Clarens Formation, the upper part of the “Stormberg Group”, Karoo Supergroup. In the Main Karoo Basin fossils are rare in the Clarens Formation as it is composed of aeolian sands and dune sands but there are rare outcrops of playa lake deposits with preserved dinosaur bones and silicified wood (Plumstead, 1969; Kitching and Raath, 1984; Anderson and Anderson, 1985; Bamford, 1999). A comprehensive study of the geology of the whole of the Springbok flats basin records no fossils from the Clarens Formation (Nel, 2012). More recent research on the Springbok Flats Basin has been done by Barbolini et al. (2019) but this focusses on the palynology of two cores and not on macrofossils. To date there are no records of fossils from this area.

From the SAHRIS map below the area is indicated as highly sensitive (orange; Figure 3) because the Clarens Formation in the Main Karoo Basin has preserved fossils in some of the outcrops, however, there is no record of fossils from the Springbok Flats south-east of Zebediela. Furthermore, the area has been disturbed by previous agricultural activities and present urban development.



Figure 3: SAHRIS palaeosensitivity map of the site for the proposed Magatle Filling Station and Shopping Centre shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	H	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	H	-
	M	-
	L	Surface soils and sands do not preserve any fossils; so far there are no records from the Clarens Fm in the Springbok Flats Basin The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	L	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	L	Since only the possible fossils within the area would be fossil or dinosaur bones from the Clarens Fm sandstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossils would be found in the soils or loose sands. No fossils have been reported from the area. Nonetheless a Fossil Chance Find protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age and sedimentary type to preserve fossils, but, because the surface is already disturbed there would be no surface fossils (i.e. in the soils). No fossils have been recorded but there is a small chance that fossils from the Clarens Formation might be present underground. Therefore, a Fossil Chance Find protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

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 dolomites, sandstones, shales and sands are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. Since the area is covered in soils, and soils do not preserve fossils, it is not possible to determine if there are fossils below the surface.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the soils and loose sands of the Clarens Formation. There is a very small chance that fossils of dinosaur bones or silicified wood may occur below ground so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found once excavations for foundations, fuel storage tanks and associated infrastructure has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodrumus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Bamford, M.K., 1999. Permo-Triassic fossil woods from the South African Karoo Basin. *Palaeontologia africana* 35, 25-40.

Cawthorn, R.G., Eales, H.V., Walraven, F., Uken, R., Watkeys, M.K., 2006. The Bushveld Complex. 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 261-281.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. 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 461 – 499.

Kitching, J.W., Raath, M.A., 1984. Fossils from the Elliot and Clarens formations (Karoo Sequence) of the north-eastern Cape, Orange Free State and Lesotho, and a suggested biozonation based on tetrapods. *Palaeontologia africana* 25, 111-125.

Nel, L., 2012. *The Geology of the Springbok Flats*. Unpublished PhD thesis, University of the Free State. 250pp.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. *Geological Society of southern Africa, Annexure to Volume LXXII*. 72pp + 25 plates.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project 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 Figure 1.5). 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 possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
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. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will not be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils from the Clarens Formation



Figure 4: a large piece of silicified wood.



Figure 6: Example of fossil bones still embedded in the sandstone.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD September 2019

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-
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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	7	0
Masters	10	4
PhD	12	5
Postdoctoral fellows	10	3

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 –
Cretaceous Research: 2014 -

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

xi) Research Output

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 135 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 30;

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)