Palaeontological Impact Assessment for the proposed borrow pits for Ledjadja Coal Mine, Limpopo Province:

Site visit

For

Digby Wells Environmental

11 February 2018

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Expertise of Specialist

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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 Digby Wells Environmental, Johannesburg, 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

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 site visit Palaeontological Impact Assessment (PIA) was completed for the proposed construction of five borrow pits for Ledjadja Coal Mine, near Stockport, Limpopo Province. SAHRA Case ID: 10852.

The proposed sites lie on the Quaternary Kalahari Sands that are south of the coal deposits of the Ellisras Basin. The site visit CONFIRMS the conclusion and recommendation of the earlier report (SAHRIS case ID: 10852) that there is no chance of finding fossils in the proposed borrow pit sites because these are on Kalahari sands, gravels, calcrete and ferricrete.

The older underlying Karoo-aged and potentially fossiliferous deposits are known from borehole material ONLY and occur more than 4m below ground. The uppermost formation, the Clarens Formation, is composed of aeolian sands and is devoid of fossils in this region (Brandl, 1996). It is concluded that there is no chance of finding fossils in the Quaternary alluvium and that as far as the palaeontology is concerned the excavation of the five borrow pits may proceed.

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1. Background

Ledjadja Coal (Pty) Ltd (hereinafter Ledjadja Coal) intends to establish five borrow pits on various farms for the purpose of providing infill material for the construction of a road diversion and rail link associated with its Boikarabelo Coal Mine (Mining Right: LP30/5/1/2/2/169MR). The proposed borrow pits will not exceed a depth of 5 m. The road and rail link to be constructed are approved Listed Activities for the Boikarabelo Coal Mine (Environmental Authorisation Reference No. 12/1/9/2-W08) issued by the Limpopo Department of Economic Development and Tourism (LEDET) in 2013.

A heritage impact assessment was completed by Digby Wells (March 2017, ref LED4349) which included a palaeontological assessment stating that there was a very small chance of finding fossils in the proposed borrow pit sites. SAHRA contested this and requested a site visit (Case ID: 10852.) The site visit report and assessment are given here.

Table 1: Specialist Report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Appendix A
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix A
A declaration that the person is independent in a form as may be specified by the competent authority	Page i
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section II
An identification of any areas to be avoided, including buffers	N/A
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

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
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
Any mitigation measures for inclusion in the EMPr	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	n/a
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
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
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

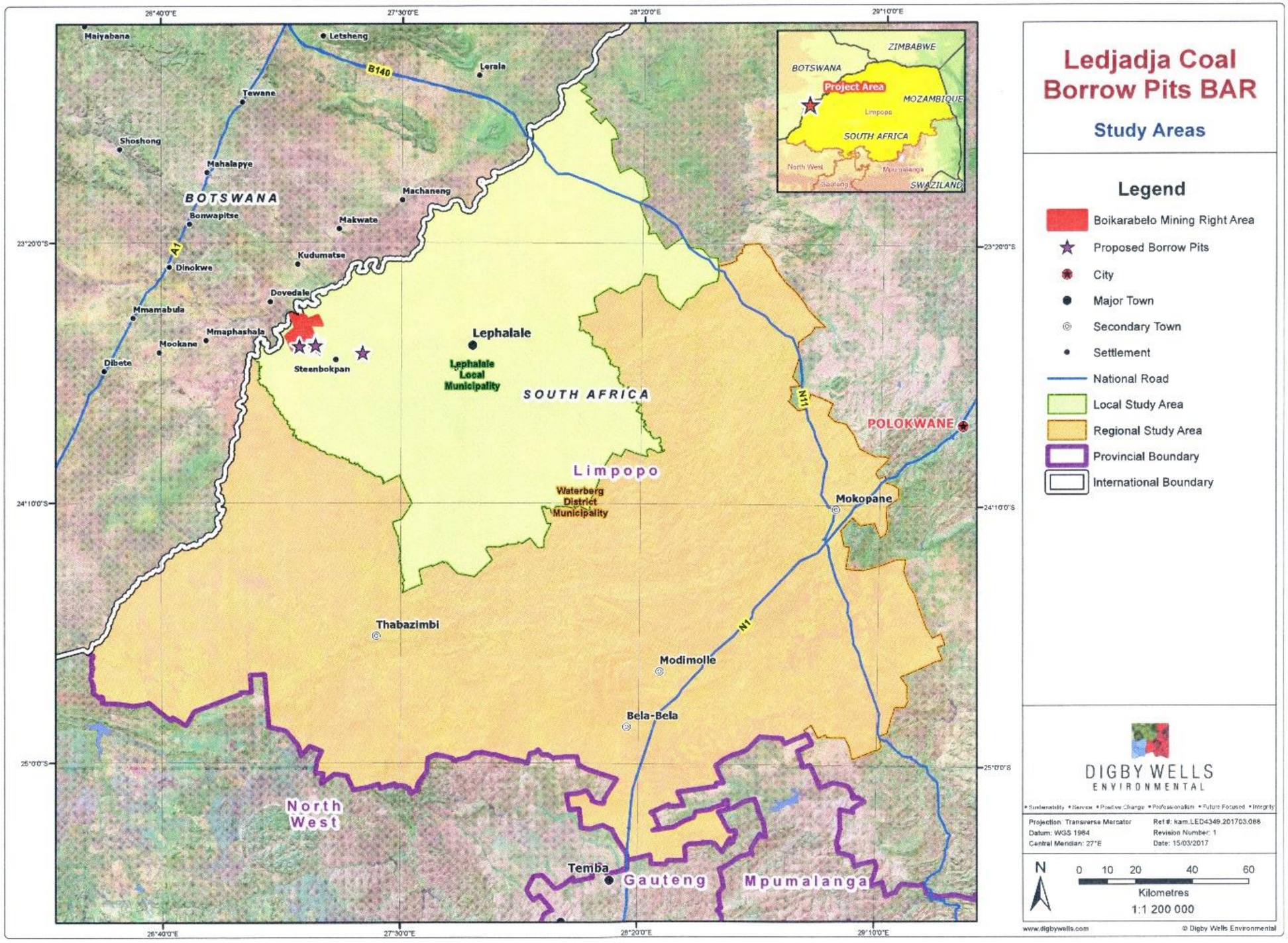

Figure 1: Detailed Map of the Boikarabelo Coal Mine and Proposed Borrow Pits for the Construction of Roads and Rail Link

Source: Map supplied by Digby Wells

Precise locations of pits are given in Table 4.

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

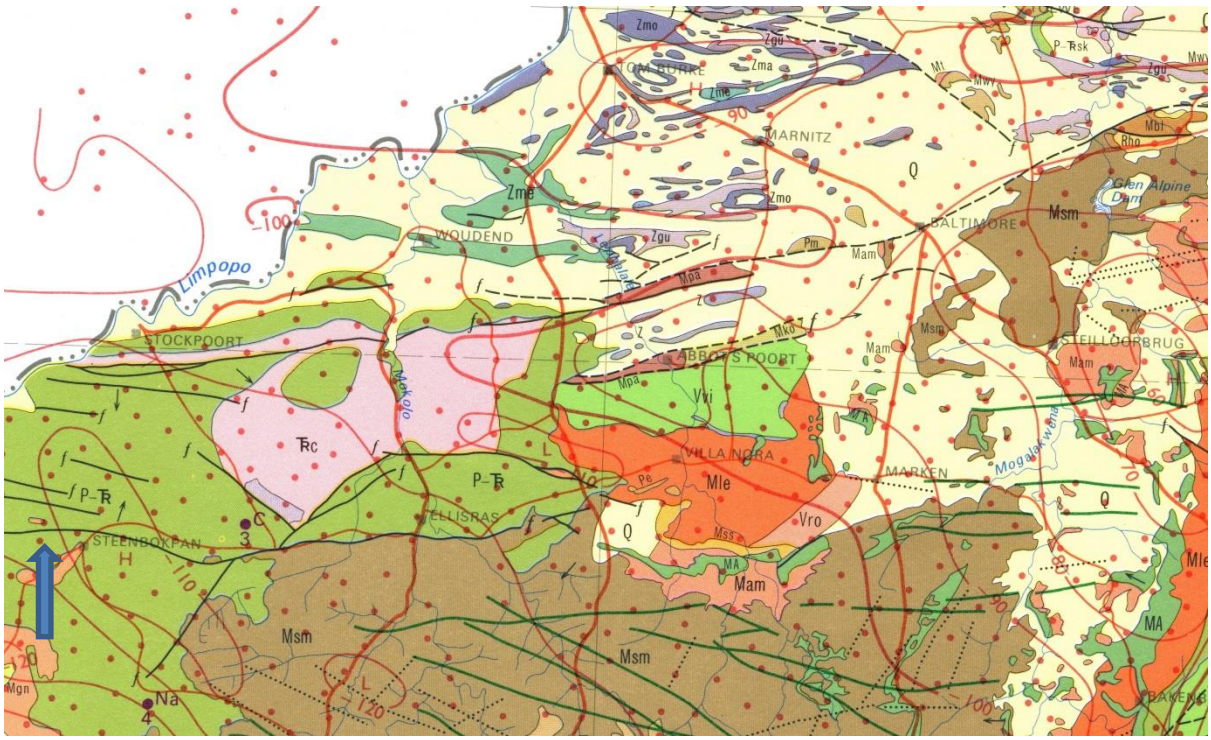

Figure 2: Geological Map of the Area around Steenbokpan and Stockpoort

The sites for the Ledjadja borrow pits are south of the coal deposits and to the west of Steenbokpan. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Sand, alluvium, calcrete	
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Tr-C	Tarkastad Subgroup, Beaufort Group	Shale, sandstone, mudstone, coal	Early Triassic 252 – 230 Ma
P-Tr	Permian Triassic	Shale, mudstone, sandstone, conglomerate, coal	Ca 290-230 Ma
C-Pd	Dwyka Group	Tillite, sandstone, mudstone, shale	Upper Carboniferous, Early Permian 295-290 Ma
Mv	Vaalwater, Formation, Kransberg subgroup, , Waterberg Group	Feldspathic sandstone, shale	2100 – 1900 Ma
Mc	Cleremont Fm (ditto)	Sandstone	
Msm	Sandriviersberg and Mogalakwena (ditto)	Sandstone, conglomerate	
Mam	Aasvoëlkop and Makabeng Matlabas Subgroup, Waterberg Group	Sandstone, mudstone	
Mle	Lebowa Granite Suite	Hornblende and biotite granite	
Vvi	Villa Nora Gabbro	Gabbro, anorthosite	
Zgu	Gumbu Group Limpopo Belt	Marble, calc-silicate rocks, leucogneiss	2200 – 2000 Ma
Zme	Mount Dowe Group Limpopo Belt	Meta-anorthosite, serpentinite, metapyroxenite	2680 – 2560 Ma

(Source: Barker et al., 2006; Kramers et al., 2006; Erikssen et al., 2006. Johnson et al., 2006)

SG = Supergroup; Fm = Formation.

The rocks of this region are known as the Limpopo Belt which is a broad zone of gneisses between the Zimbabwe Craton and the Kaapvaal Craton. The rocks have undergone low to medium grade metamorphism and range in age from about 2100 to 1900 Ma (Kramers et al., 2006). Much older rocks of the Gumbu Group and Mount Dowe group are also in the area. Unconformably overlying these ancient rocks are sediments of the Ellisras Basin which are contemporaneous with the Main Karoo Basin (Johnson et al., 2006). These sediments are further divided into formations (Table 3) and are known from borehole core only (Siepker, 1986; Brandl, 1996) because "with the exception of a few arenaceous units, the Karoo Supergroup is very poorly exposed" (Johnson et al., 2006, p 487)

Table 3: Local Stratigraphy of the Ellisras Basin from Brandl (1996) based on Borehole Cores

Formation	Lithology	Notes
Quaternary	Calcrete, ferricrete, terrace gravel, soil, unconsolidated red sand, alluvium and scree	Late Middle Pleistocene
Tertiary deposits	Gravel and sand, sometimes calcified	Occur close to rivers
Letaba Fm	Basaltic lava	125m thick (boreholes) south of Zoetfontein Fault and northeast of Grootgeluk mine only
Clarens Fm	Massive sandstone, aeolian	130m thick. Forms hills and ridges
Lisbon Fm	Red massive mudstone, siltstone, silty sandstone, calcareous concretions	100-110m thick. Exposures only in bed of Limpopo river, Lisbon 19 LQ
Greenwich Fm	Sandstone, minor conglomerates	Borehole: narrow band
Eendragtpan Fm	Variegated mudstones	110m (central) to 40m thick (north); fine-grained, no plant material (p 34)
Grootgeluk Fm	Mudstone, carbonaceous shale, coal	10-110m thick; *Glossopteris* leaves common, pollen
Goedgedacht Fm	Sandstones, siltstones, coaly mudstones, very thin coal layers	Only in north and northwestern part of basin
Swartrant Fm	Sandstone, siltstone	3 zones, each with *Stigmaria* roots
Wellington Fm	Mudstone, siltstone and sandstone lenses	Pollen (MacRae, 1991) C-P boundary

Formation	Lithology	Notes
Waterkloof Fm	Diamictite, mudstone, conglomerate	Borehole: deeply weathered
Diabase intrusions		

II. Palaeontological Context

The Gumbu and Mount Dowe Suites intrusive rocks and the gneisses of the Waterberg Group are of the wrong type and too old to contain fossils so will not be considered any further. Based on numerous borehole cores the stratigraphy of the Ellisras Basin has been determined and the coal deposits assessed (Brandl, 1996; Snyman, 1998). Coal seems occur in the Grootgeluk Formation and are mined extensively in the area to the north and northwest of Lephalale (formerly Ellisras). Some *Stigmaria* roots have been recorded from the Swartrand Formation and leaf impressions of *Glossopteris* from the Grootgeluk Formation (Brandl, 1996; Johnston et al., 2006). The overlying Clarens Formation is predominantly composed of Aeolian sand and, apart from a few non-diagnostic root traces in core material, does not contain any fossils (Brandl, 1996).

The proposed borrow pits will only excavate loose sands, gravel, calcrete and ferricrete from the surface layer, not the underlying formations.

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The main coal deposits are in the northern part of this area and show up as red in the palaeosensitivity map.

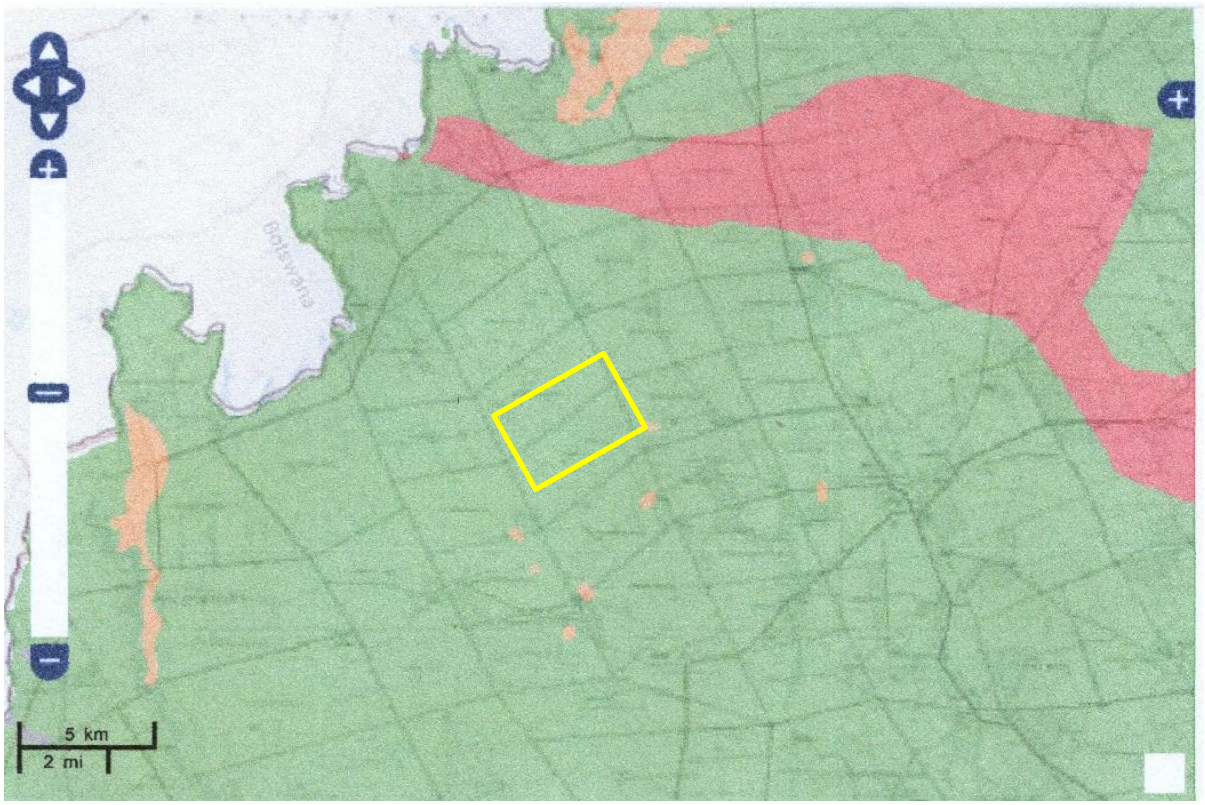

Figure 3: SAHRIS Palaeosensitivity Map for the Region

The proposed borrow pits are within the yellow rectangular outline. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

III. Description of the Scope of the Proposed Overall Activity and Results of Site Visit

Ledjadja Coal intends to establish five borrow pits on various farms for the purpose of providing infill material for the construction of a road diversion and rail link associated with its Boikarabelo Coal Mine (Mining Right: LP30/5/1/2/2/169MR). The proposed borrow pits will not exceed a depth of 5 m. The road and rail link to be constructed are approved Listed Activities for the Boikarabelo Coal Mine (Environmental Authorisation Reference No. 12/1/9/2-W08) issued by the Limpopo Department of Economic Development and Tourism (LEDET) in 2013.

Location details of the proposed borrow pits is presented in Table 4 below together with the observations and results of the site visit on 1-3 February 2018 by the palaeontologist.

Table 4: Location Details of the Proposed Borrow Pits

Name	Total Footprint Size	Location	Co-ordinates
Rail link borrow pits			
BP 3	5 ha	Loopleegte 302 LQ	23° 41' 13.191" S 27° 21' 53.516" E
Site visit: along current access road. Landscape flat with covering of Kalahari sands. Dominant trees: Sclerocarya birrea, Combretum apiculatum, Boscia albitruna, Acacia nilotica; shrubs: Grewia flava, Grewia flavescens, Grewia retinervis, Dichrostachys cinerea. Deep sands, minor gravel component, calcrete. No fossils or shales observed.			Photographs Fig 4
BP 5	1.5 ha	Bitterfontein 272 LQ	23° 39' 18.054" S 27° 12' 14.914" E
Site visit: flat landscape with open mixed bushveld of *Sclerocarya birrea* (marula) and *Combretum apiculatum* (red bushwillow) trees dominating; shrubs *Grewia flava, Grewia retinervis Acacia mellifera*; grasses very sparse – *Aristida* sp. Soil Kalahari sand at least 1.5 m deep. No shales or potentially fossiliferous sediments were observed			Photographs: Fig 5
Road diversion borrow pits			
BRD 1	3.5 ha	Bitterfontein 272 LQ	23° 39' 48.141" S 27° 12' 6.241" E
Site visit: flat landscape with open mixed bushveld of *Sclerocarya birrea* (marula) and *Combretum apiculatum* (red bushwillow) trees dominating; shrubs *Grewia flava, Acacia mellifera Maytenus* sp.; grasses very sparse – *Aristida* sp. Soil Kalahari sand at least 1.5 m deep. No shales or potentially fossiliferous sediments were observed.			Photographs: Figure 7 and Figure 8
BRD 3	5 ha	Vlughtkraal 273 LQ, Portion 1	23° 39' 55.420" S 27° 8' 46.413" E

Name	Total Footprint Size	Location	Co-ordinates
Site visit: flat landscape with open mixed bushveld of Boscia albitrunca, Boscia foetida, Acacia sieberiana, Sclerocarya birrea, Combretum apiculatum trees dominating; shrubs Grewia flava, Acacia mellifera; grasses very sparse – Aristida congesta. Soil Kalahari sand at least 1.5 m deep. No shales or potentially fossiliferous sediments were observed			Photographs: Figure 9 and Figure 10
BRD 5	5 ha	Kamiesbult 291 LQ, RE	23° 40' 24.649" S 27° 12' 1.398" E
Site visit: flat landscape with open mixed bushveld of Boscia albitrunca, Boscia foetida, Acacia nilotica, Sclerocarya birrea, Combretum apiculatum trees dominating; shrubs Grewia flava, Grewia retinervis, Acacia mellifera; grasses very sparse – Aristida congesta. Soil Kalahari sand at least 1.5 m deep. No shales or potentially fossiliferous sediments were observed			Photographs: Figure 11, Figure 12,Figure 13 and Figure 14

IV. Description of the Activities to be undertaken

i. Mining Method

The mining method to be applied to all borrow pits includes:

1. Stripping and stockpiling of topsoil along the edge of the borrow pit;
2. Free-dig excavation of the gravel material resource utilising front-end loaders;
3. Backfilling of the excavated borrow pits with any excess gravel; and
4. Spreading the stockpiled topsoil and vegetation establishment.

It is proposed that each borrow pit will be excavated and rehabilitated within a two year period.

ii. Material Utilisation

Cumulatively, the borrow pits will yield approximately 254 288 m^3 of infill material to construct the road diversion and rail link. A description of the borrow pit areas and material of which will be excavated are discussed per borrow pit below.

a. Rail Link Borrow Pits

BP 3

BP 3 is proposed to be established on the farm Loopleegte 302 LQ and will provide infill material for the railway link. BP 3 will result in a total disturbed area of 5 ha including an existing borrow pit to be incorporated and laydown area.

The BP 3 borrow pit will be utilised to provide infill material for the rail link contains predominately calcrete, medium gravel sand and loose silty sand material. It is estimated that BP 3 can yield 74 739 m^3 of material and will be excavated to an average depth of 3 m.

BP 5

BP 5 is proposed to be established on the farm Bitterfontein 272 LQ. BP 5 will result in a total disturbed area of 1.5 ha including a laydown area.

The BP 5 borrow pit will be utilised to provide infill material for the rail link and contains predominately Calcrete, soft sandstone and sandy soil. It is estimated that BP 5 can yield 32 413 m^3 of material and it is proposed to be mined to an average depth of 4 m.

b. Road Diversion Borrow Pits

BRD 1

BRD 1 is proposed to be established on the farm Bitterfontein 272 LQ. BRD 1 will result in a total disturbed area of 3.5 ha including a laydown area.

The BRD 1 borrow pit will be utilised to provide infill material for the road diversion and contains predominately Ferricrete and sandy soil. It is estimated that BRD 1 can yield 48 759 m^3 of material and will be excavated to an average depth of 2 m.

BRD 3

BRD 3 is proposed to be established on Portion 1 of the farm Vlughtkraal 273 LQ to provide infill material for the road diversion. BRD 3 will result in a total disturbed area of 5 ha including a laydown area.

The BRD 3 borrow pit contains predominately moist sandy soil, Ferricrete sandy soil and weathered shale sand material. It is estimated that BRD 3 can yield 183 290 m^3 of material and will be excavated to an average depth of 5 m.

BRD 5

BRD 5 is proposed to be established on the RE of the farm Kamiesbult 291 LQ to provide infill material for the road diversion. BRD 5 will result in a total disturbed area of 5 ha including a laydown area.

The BRD 5 borrow pit contains predominately moist sandy soil, Ferricrete pebbles and weathered shale sand material. It is estimated that BRD 5 can yield 80 087 m^3 of material and will be excavated to an average depth of 3 m.

Figure 4 to Figure 14 are site photographs taken 02-03 February 2018 by M Bamford.

Figure 4: Proposed site for rail link borrow pit BP3 on farm Loopleegte 302 LQ

Note the sandy substrate and small hole in front of the pile of sand in front of the cluster of trees just right of centre excavated by an animal. The hole was 1m deep and red sand occurred here.

Figure 5: Rail link borrow pit BP 5 proposed site on farm Bitterfontein 272 LQ

Note sandy substrate and *Combretum apiculatum* trees.

Figure 6: BP5 – close up of loose sandy substrate

Figure 7: BRD 1 proposed site on farm Bitterfontein 272 LQ

Note bushland of *Combretum apiculatum* and *Grewia flava* on a sandy substrate.

Figure 8: BRD 1 proposed site

Detail of uniform sandy substrate seen in a deep hole excavated by animals.

Figure 9: BRD 3 proposed site on farm Vlughtkraal 293 LQ

Note fairly sparse bushland vegetation on sandy substrate.

Figure 10: BRD 3 – animal hole showing uniform and deep sandy substrate (measured depth s 1.5m)

Figure 11: BRD 5 proposed road diversion borrow pit on farm Kamiesbult 291 LQ, RE

Note bushveld vegetation of *Combretum apiculatum, Grewia flava* and *Acacia nilotica* (right background) on sandy substrate.

Figure 12: BRD 5 *Boscia foetida*

Figure 13: BRD 5 site – a lump of ferricrete exposed on the sand

Figure 14: BRD 5 site – sandy substrate with gravel

4. Impact Assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 5 and Table 6.

Table 5: 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.

PART A: DEFINITION AND CRITERIA		
	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 6: Impact Assessment

PART B: ASSESSMENT		
SEVERITY/NATURE	H	-
	M	-
	L	No fossils occur in the Kalahari alluvium so the impact will be zero
	L+	-
	M+	-
	H+	-
DURATION	L	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	L	Since only the surface (down to 4m) sands, gravel, calcrete and ferricrete will be excavated and used for road and rail construction there will be NO impact on the potential fossils associated with the coals which occur to the north and well below surface. The spatial scale will be localised within the site boundary.
	M	-

PART B: ASSESSMENT		
	H	-
PROBABILITY	H	-
	M	-
	L	There is no chance of finding fossils in the Quaternary alluvium

Based on the nature of the project, ONLY surface activities are planned to obtain sand, gravel, calcrete and ferricrete for road and rail construction. Fossils do not occur in this level. They most likely occur in association with the coal deposits but that is a separate project in a separate location. Taking account of the defined criteria, the potential impact to fossil heritage resources is zero.

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 sands, gravels, calcretes and ferricretes are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. This was confirmed by a site visit by the palaeontologist on 1-3 February 2018..

6. Recommendation

Based on the first report and CONFIRMED by the site visit there are no fossils in the proposed sites for the five borrow pits that have been determined for Ledjajda Coal. It is the opinion of the palaeontologist that this project may proceed.

7. References

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Curriculum vitae (short) - Marion Bamford PhD

January 2018

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor;
		Director of the Evolutionary Studies Institute.

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		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

V) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	5	2
Masters	6	3
PhD	9	3
Postdoctoral fellows	5	3

VI) 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.

VII) 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

VIII) 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

IX) Research Output

Publications by M K Bamford up to January 2018 peer-reviewed journals or scholarly books:

over 110 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 22; Google scholar h index = 24;

Conferences: numerous presentations at local and international conferences.

X) 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)