Construction of a new Dam and Associated Infrastructure as part of the Upgrading of the Bulk Water Supply Scheme to Amsterdam, Mpumalanga

Gert Sibande District Municipality, Mpumalanga Province

Farm: Remainder of Portion 11 of the Farm Amsterdam 408 IT

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 993 3110

Palaeontological Impact Assessment: Desktop Study

Commissioned by: AdiEnvironmental cc

P.O. Box 647, Witbank, 1035

031 697 5021

2017/06/30

Ref: Pending

B. Executive summary

Outline of the development project: AdiEnvironmental cc appointed Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1 Field study of the suitability of the Proposed Construction of a New Dam and Associated Infrastructure as part of the Upgrading of the Bulk Water Supply Scheme to Amsterdam, within the Gert Sibande District Municipality in the Mpumalanga Province.

The applicant, Gert Sibande District Municipality Proposed Construction of a New Dam and Associated Infrastructure as part of the Upgrading of the Bulk Water Supply Scheme to Amsterdam.

The Project includes two Alternatives (Figure 3):
Alternative 1: Proposed dam site A located north of Kwathandeka Township in the Thole River. This will be a new dam and raw water pumpstation.
Alternative 2: Proposed dam site B located upstream of the Dorps Dam in the Gabosha River. This will be a new dam and raw water pumpstation.

Legal requirements:-

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

A Palaeontological Impact Assessment is generally warranted where rock units of LOW to VERY HIGH palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

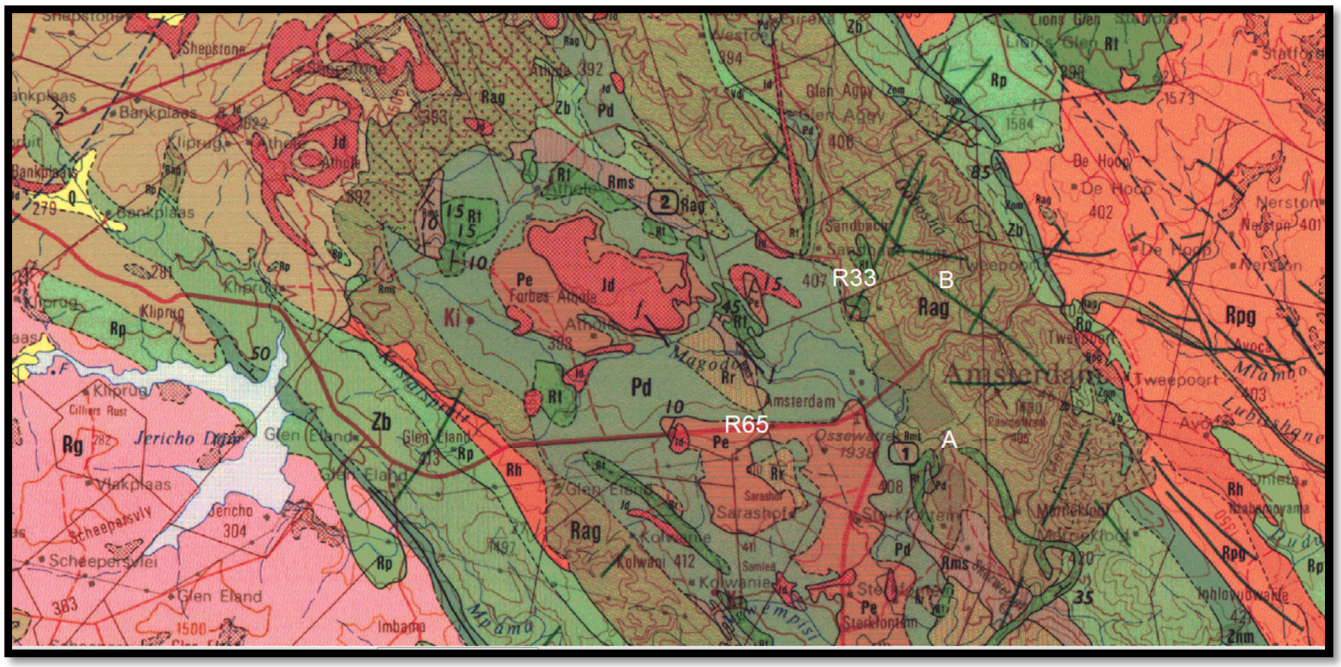
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).
Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear

development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:
The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and 1:250 000, 2630 Mbabane Geological Map (Walraven 1986).

Figure 3: The geology of the development area.



Legend to map and short explanation.
Pd – Tillite and shale with dropstones, fluvioglacial sediment (grey). Dwyka Group, Karoo Supergroup. Permian.
Rag – Pyroclastic rocks, ashflow tuff (khaki). Gobosha Member, Amsterdam Formation. Randian.
Rt – Ultrabasic rocks, pyroxenite, norite (green). Suite Thole. Randian.
Rms – Quartzite with interlayered shale (brown). Skurwerant Formation. Mozaan Group, Pongola Supergroup. Randian.
…… – (black) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
⊥35 – Strike and dip of layer.
[1] – Site of geological interest.
A,B – Position of proposed dam sites.

Mining Activities:
None.

Summary of findings (1d): The Desktop Study was undertaken towards the middle of June 2017 in the winter in dry and cold conditions. As this is a desktop study the season and conditions has no influence on the outcome and the following is reported:

Formations present are part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth. The Dwyka Group is the lowermost unit of the Karoo Supergroup overlain by the Ecca Group and underlain by the Witteberg Group, Bokkeveld or Table Mountain Groups and various other groups. It ranges in age from Late Carboniferous to early Permian. Clastic rocks containing diamictite, varved shale, conglomerate, pebbly sandstone and mudrock are present. The rocks display features reflecting a glacial and glacially-related origin. Fossils are present (Kent 1980, Visser *et al.* 1990). Thickness varies between 100-800 m (Visser *et al.* 1990). As Gondwana drifted northward the first sediments to be deposited would have been the Dwyka. As the glaciers melted they left striations on the surface also vast quantities of mud and large fragments of rock which formed the characteristic, poorly sorted Dwyka tillite (McCarthy and Rubidge 2005). Visser *et al.* (1990) proposed two subdivisions for the Dwyka Group in the main Karoo basin, the Elandsvlei and Mbizane Formations. In the far north, the Tshidzi and Wellington Formations also form part of the Dwyka Group.

The Skurwerant Formation is the basal unit of the Mozaan Group and can be up to 400 m thick. The Suite Thole is older than the Amsterdam Formation. A thickness of 250 m is reached by the Amsterdam Formation which is in the form of a syncline. Rhyolite is present at the base and top. Two Members are present, the Gabosha Dacite and the Vaalkop Rhyolite.

Formations present at proposed dam site A are the Amsterdam Formation and small portion of the Suite Thole and Dwyka Group. The Amsterdam Formation is present at proposed dam site B.

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **MODERATE** for the Dwyka Group (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The potential impact of the development on fossil heritage is **MODERATE** and therefore a Desktop Study was conducted. A Phase 1 PIA and or mitigation is not recommended, but the overburden and inter-burden consisting of Dwyka rocks must be surveyed for fossiliferous outcrops (shale).

During the study it was found that part of the site is directly underlain by Dwyka rocks and is presently part of a river system. It is located on a sloping topography. The development includes the dam and raw water pump station and new storage reservoir with related infrastructure such as pipe lines.

The Project includes two Alternatives (Figure 3):
Alternative 1: Proposed dam site A located north of Kwathandeka Township in the Thole River. This will be a new dam and raw water pumpstation.
Alternative 2: Proposed dam site B located upstream of the Dorps Dam in the Gabosha River. This will be a new dam and raw water pumpstation.

Alternative 2 is preferred. Dam site B is a good option as it will be present in the Amsterdam Formation with a Very Low Palaeontological Sensitivity.

Concerns/threats (1g,1ni,1nii,1o,1p):

1. Threats are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic and human disturbance.
2. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden during construction not to intrude surrounding or underlying fossiliferous layers. An appropriate protocol and management plan is attached (Appendix 1).
3. Mitigation is needed if a fossil or traces of it is found (Appendix 1). Permission is needed from SAHRA.
4. No consultation with parties was necessary. Shale (mudstone) cannot be blasted without being checked for fossils. The development can go ahead with caution for the shale / diamictite layer. The Environmental Control Officer must check for fossils. If a fossil is found, all construction must stop, and SAHRA must be notified.

Stakeholders: Developer – Gert Sibande District Municipality. P.O. Box 1748, Ermelo, 2350. Tel: 017 801 7214.
Environmental – AdiEnvironmental cc. P.O. Box 647, Witbank, 1035. Tel: 013 697 5021.
Landowner – Mkhondo Local Municipality.

C. Table of Contents

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (GN R38282 of 4 December 2014) of the Environmental Impact Assessment Regulations (see Appendix 1).

Outline of development

This report discusses and aims to provide the applicant with information regarding the location of palaeontological material that will be impacted by the development. It may be necessary for the applicant to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA) if a fossil is found.

The applicant, Gert Sibande District Municipality intends to construct a new dam and abstraction facility in either the Gabosha River or the Thole River in order to improve the delivery of potable water to the Amsterdam and

Kwathandeka communities. The Amsterdam Regional Water Supply Scheme currently serves a population of approximately 14 500 people who reside within the boundaries of the scheme. These residents are reliant on the scheme to provide a sustainable water supply. The scheme currently abstracts water from a single location within the catchment of the Gabosha River and is not connected to any National Bulk Water Infrastructure.

Two possible dam sites were identified, namely Dam Site A and Dam Site B. Proposed dam Site A is located in close proximity to KwaThandeka within the Thole River. This dam will have a full supply capacity of 0.55 mm³. Proposed dam Site B is located upstream of Amsterdam and the Amsterdam WTW within the Gabosha River. Both sites are located on the Remainder of Portion 11 of the Farm Amsterdam 408 IT. Dam site A may not be ideal due to the resultant flooding of houses, grazing lands, sewer line, and could end up polluted.

As part of the project, a bulk water pipeline (orange) will be installed from the dam site to the existing Amsterdam Water Treatment (Purification) Works (WTW) while a distribution pipeline (yellow) will be installed from the WTW to Amsterdam/KwaThandeka. In addition, the Dorps Dam will be desilted and the Amsterdam WTW upgraded.

Rezoning/ and or subdivision of land: No.
Name of developer and consultant: Gert Sibande District Municipality and AdiEnvironmental cc.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. For the past ten years she carried out field work in the Eastern Cape, Free State, Gauteng, Limpopo and Mpumalanga Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 21 years.
Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA.

E. Description of property or affected environment
Location and depth:
The Proposed Construction of a New Dam and Associated Infrastructure as part of the Upgrading of the Bulk Water Supply Scheme to Amsterdam, will be situated within the Gert Sibande District Municipality in the Mpumalanga Province. Both Proposed Dam Sites A and B are located on the Remainder of Portion 11 of the Farm Amsterdam 408 IT.

The pipelines will also be located on the Remainder of Portion 11 of the Farm Amsterdam 408 IT within the Amsterdam/KwaThandeka urban area.

The project is necessary in order to improve the delivery of potable water to the Amsterdam and KwaThandeka communities.

Figure 1: Topographic map to show location of proposed dam sites (2630DA) (AdiEnvironmental cc)

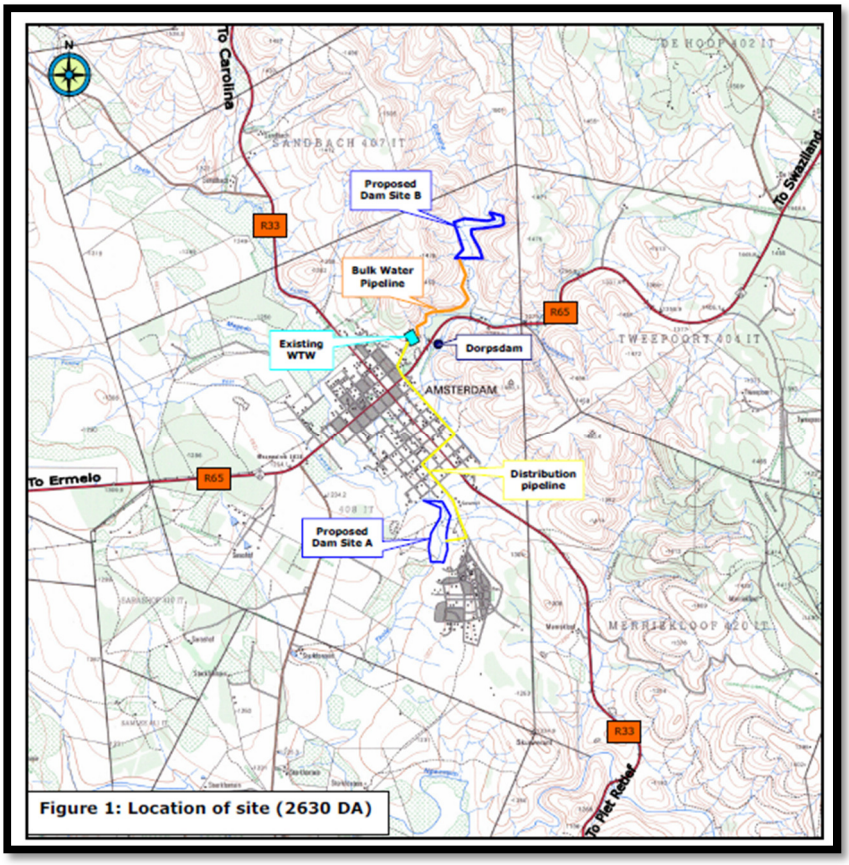


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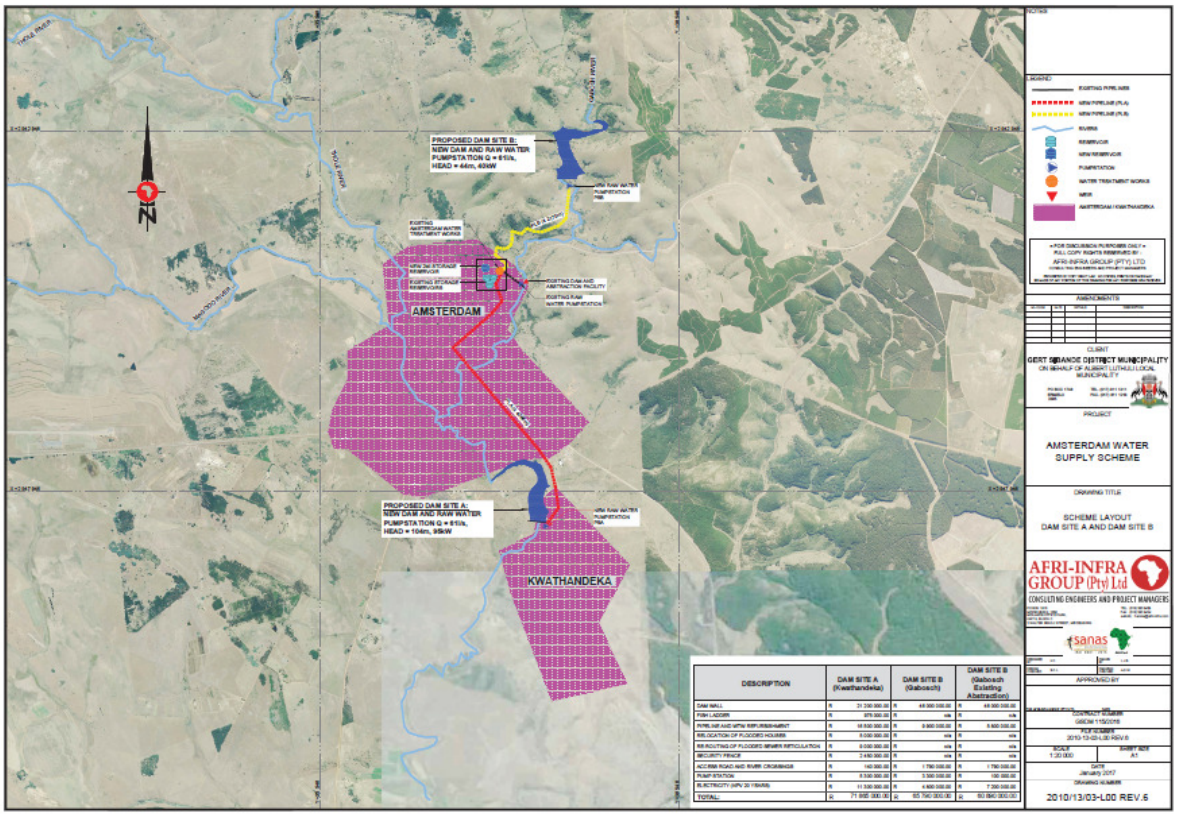
Figure 2: Google.earth image showing scheme layout (AdiEnvironmental cc).



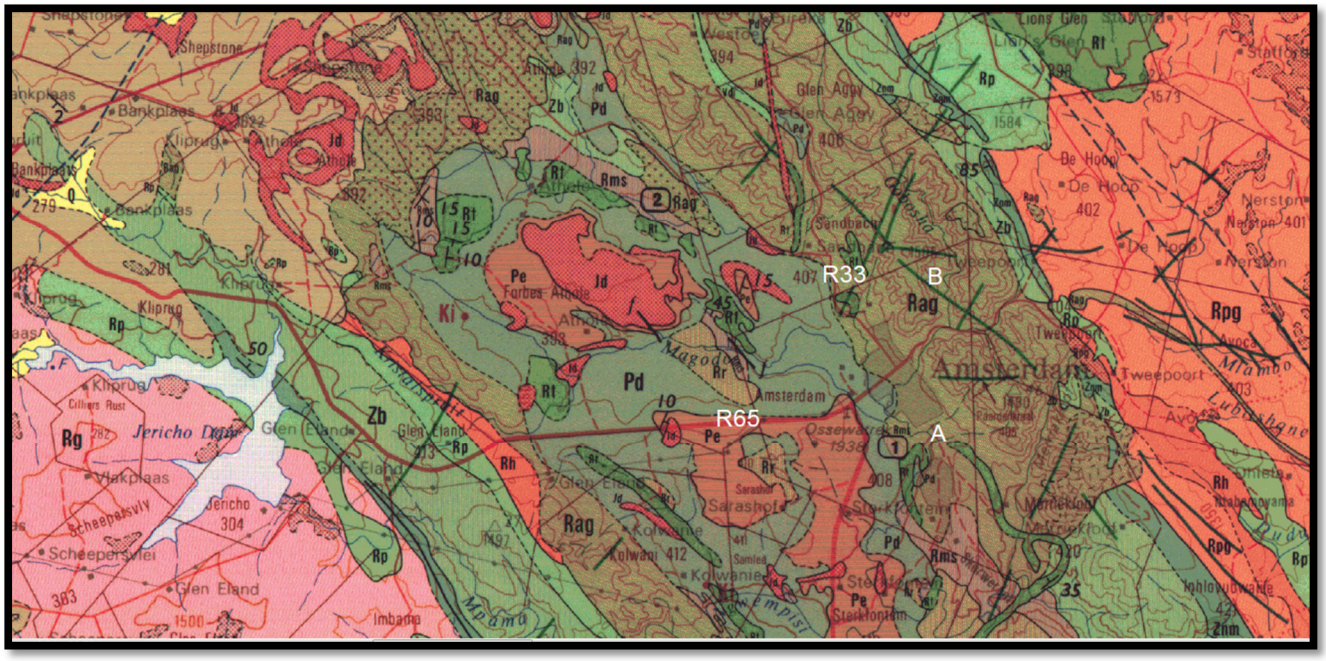
Proposed dam Site A is partly underlain by the Dwyka Group, Karoo Supergroup sediments covered by grassland.

F. Description of the Geological Setting

Description of the rock units:

Large areas of the southern African continent are covered by the Karoo Supergroup. The Ecca Group is early to mid-Permian (545-250 Ma) in age. Sediments of the Ecca group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Ecca group is known for its coal (mainly the Vryheid Formation) (five coal seams) and uranium. Coalfields formed due to the accumulation of plant material in shallow and large swampy deltas (see Appendix 1). The Ecca Group conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group, Karoo Supergroup. It consists essentially of mudrock (shale), but sandstone-rich units occur towards the margins of the present main Karoo basin in the south, west and north-east, with coal seams also being present in the north-east (Kent 1980, Johnson 2009).

Figure 3: Excerpt of 1:250 000 Geological Map 2630 Mbabane (Walraven 1986).



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⊥35 – Strike and dip of layer.

A,B – Position of proposed Dam sites.

The Dwyka Group is the lowermost unit of the Karoo Supergroup overlain by the Ecca Group and underlain by the Witteberg Group, Bokkeveld or Table Mountain Groups and various other groups. It ranges in age from Late Carboniferous to early Permian. Clastic rocks containing diamictite, varved shale, conglomerate, pebbly sandstone and mudrock are present. The rocks display features reflecting a glacial and glacially-related origin. Fossils are present (Kent 1980, Visser *et al.* 1990). Thickness varies between 100-800 m (Visser *et al.* 1990). As Gondwana drifted northward the first sediments to be deposited would have been the Dwyka. As the glaciers melted they left striations on the surface also vast quantities of mud and large fragments of rock which formed the characteristic, poorly sorted Dwyka tillite (McCarthy and Rubidge 2005). Visser *et al.* (1990) proposed two subdivisions for the Dwyka Group in the main Karoo basin, the Elandsvlei and Mbizane Formations. In the far north, the Tshidzi and Wellington Formations also form part of the Dwyka Group. Dwyka tillite may show very well-developed spheroidal or 'onion skin' weathering (Norman 2013).

The Pongola Supergroup (3100 – 2900 Ma) is exposed in four areas extending from southern Swaziland, across the south-eastern Mpumalanga Province into northern KwaZulu Natal Province, a distance of some 260 km. This Supergroup has a maximum thickness of 10 650 m. It is subdivided into the Upper Mozaan Group and Lower Insuzi Group. The Insuzi Group is made up of the Montanga Quartzite and the Bivane Formation in the Amsterdam area. It contains stromatolites. The Redcliff Formation is underlain by the Skurwerant Quartzite Formation (Kent 1980, Visser 1989).

The Skurwerant Formation is the basal unit of the Mozaan Group and can be up to 400 m thick. The Suite Thole is older than the Amsterdam Formation. A thickness of 250 m is reached by the Amsterdam Formation which is in the form of a syncline. Rhyolite is present at the base and top. Two Members are present, the Gabosha Dacite and the Vaalkop Rhyolite.

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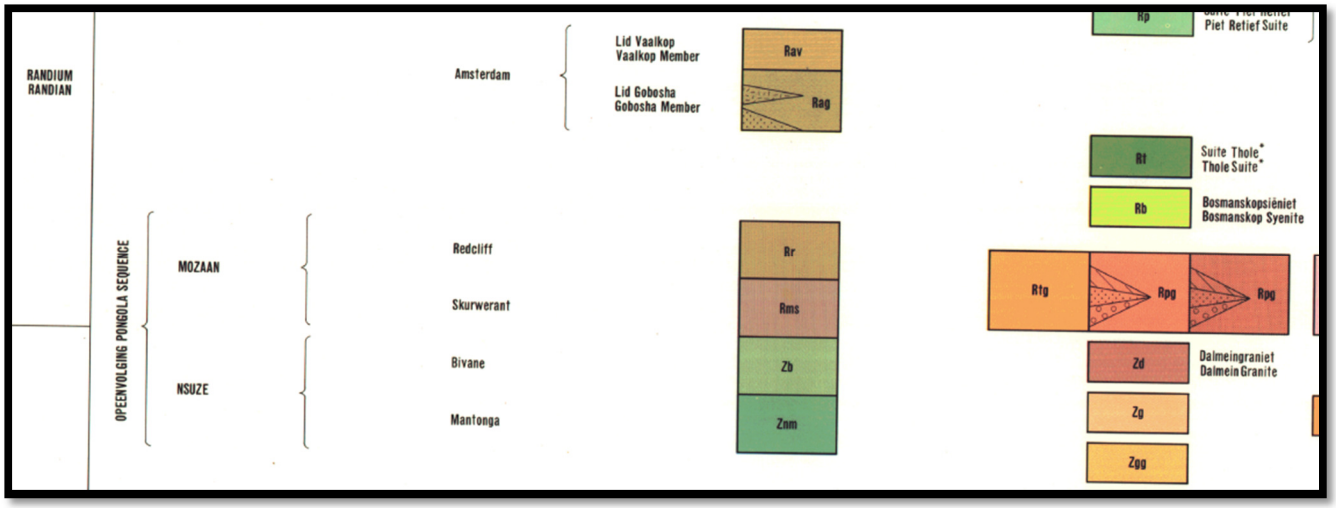
Figure 4: Lithostratigraphic column to show the geological formations present (Walraven 1986).

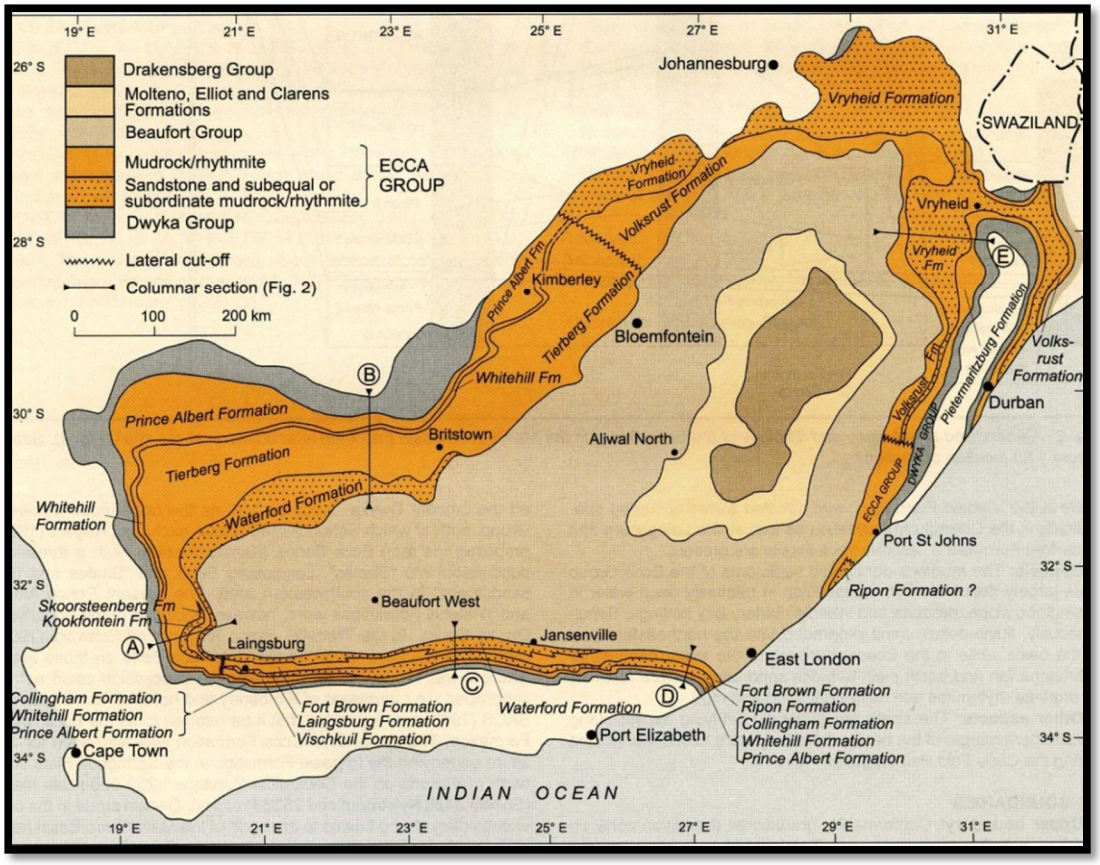


Dam site A may not be ideal due to the resultant flooding of houses, grazing lands, sewer line, and could end up polluted. A small portion of the dam will also be present on the Dwyka Group which is of concern due to the possible presence of fossils. The depth of the Dwyka Group can be verified with geological cores. The topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed if a fossil is found.

Dam site B is a good option as it will be present in the Amsterdam Formation with a Very Low Palaeontological Sensitivity.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).



Map 1: Extent of the Dwyka Group (Johnson 2009).

Spores and acritarchs have been reported from the interglacial mudrocks of the Dwyka Group, also spores, pollen and plant remains in the interbedded mudrocks as well as the diamictite itself, while anthropod trackways and fish trails are present in places on bedding planes (Visser *et al.* 1990). Stromatolites are present in the Insuzi Group (Kent 1980).

Subgroup / Supergroup	Group	Formation	Fossil Heritage	Comment
Karoo Supergroup	Dwyka	-	Most of the fossils are recorded from the mudstone facies, and include spores, pollen, plant remains, arthropod trackways and fish trails	Globally important and under collected

Table 1: Taken form palaeotechnical report (Groenewald and Groenewald 2014).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **MODERATE** for the Dwyka Group.

Rock Unit	Significance/vulnerability	Recommended Action
Dwyka Group (Pd)	Moderate	Desktop study is required

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA).

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).

Impact: **MODERATE** for the Dwyka Group. There are significant fossil resources that may be impacted by the development (shale).

H. Description of the Methodology (1e)

The palaeontological impact assessment desktop study was undertaken towards the middle of June 2017. A literature survey is included.

Assumptions and Limitations:-

The accuracy and reliability of the report may be limited by the following constraints:

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.
4. Lack of published data.
5. Lack of rocky outcrops.
6. Insufficient data from developer and exact lay-out plan for all structures.

A Phase 1 Palaeontological Impact Assessment: Field Study will include:

1. Recommendations for the future of the site.
2. Background information on the project.
3. Description of the property of affected environment with details of the study area.
4. Description of the geological setting and field observations.
5. Background to palaeontology of the area.
6. Heritage rating.
7. Stating of significance (Heritage Value).

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

The National Heritage Resources Act No. 25 of 1999 further prescribes -

Act No. 25 of 1999. National Heritage Resources Act, 1999. The National Estate as: 3 (2) (f) archaeological and palaeontological sites, (i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens, Heritage assessment criteria and grading used: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance; (b) Grade 11: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and (c) Grade 111: Other heritage resources worthy of conservation. SAHRA is responsible for the identification and management of Grade 1 heritage resources. Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 11 heritage resources. Local authorities identify and manage Grade 111 heritage resources.

No person may damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of a provincially protected place or object without a permit issued by a heritage resources authority or local authority responsible for the provincial protection.

Archaeology, palaeontology and meteorites: Section 35.
(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (*e. g.* during bedrock excavations), this must be safeguarded, where feasible *in situ,* and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (*e. g.* Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences (1f)

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially **MODERATE** for the Dwyka Group. Plant fossils have been described from outcrops of the Dwyka Formation in Limpopo Province, with special reference to this formation in the Springbok Flats region. Outcrops of the formation are however rare in the Mpumalanga Province and any recording of fossils will be highly significant (Groenewald and Groenewald 2014).

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot.

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1j,1l)

a. There is no objection (see Recommendation B) to the development, and it is not necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is **MODERATE**. A Phase 2 Palaeontological Mitigation is not required, but caution is required due to the presence of the fossiliferous Dwyka Group at Proposed dam site A. Protocol is attached (Appendix 2).

b. This project will benefit the economy, the growth of the community, health and social development of the community.

c. Preferred choice: Preferred Alternative – Proposed dam site B as it is not underlain by the Dwyka Group. The impact on the palaeontological heritage is **MODERATE.** The presence of shale is problematic at Proposed dam site A which may need mitigation if a fossil is found during construction. Care must be taken during the digging of foundations and removing topsoil, subsoil and overburden (see Executive Summary).

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.

Sampling and collecting (1m,1k):

Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

a. Objections: Cautious. See heritage value and recommendation.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: **Yes** for the mudrock and diamictite at Proposed dam site A.
d. Permits for mitigation: **Needed from SAHRA/PHRA prior to Mitigation**.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
b. All information needed for the Palaeontological Impact Assessment was provided by the Consultant. All technical information was provided by AdiEnvironmental cc.
c. Areas that would involve mitigation (i.e. Proposed dam Site A) and may need a permit from the South African Heritage Resources Agency are discussed.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures, especially for shallow caves.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment and adjacent areas as well as for safety and security reasons.

L. Bibliography

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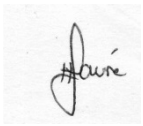
Declaration (disclaimer) (1b)

I, Heidi Fourie, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project for which I was appointed to do a palaeontological assessment. There are no circumstances that compromise the objectivity of me performing such work.

I accept no liability, and the client, by receiving this document, indemnifies me against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

It may be possible that the Desktop Study may have missed palaeontological resources in the project area as outcrops are not always present on geological maps while others may lie below the overburden of earth and may only be present once development commences.

This report may not be altered in any way and any parts drawn from this report must make reference to this report.



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Heidi Fourie
2017/06/30

Appendix 1: **Protocol for finds and Management plan**

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is **LOW**; this process guides the palaeontologist / palaeobotanist /ECO on site and should not be attempted by the layman / developer. The developer needs to employ an Environmental Control Officer (ECO) to oversee the construction activities so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. The ECO should familiarise him- or herself with the applicable formations and its fossils. Miners and construction workers should be informed that fenced-off areas are no-go areas. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of fossils.

The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

The Palaeontological Society of South Africa (PSSA) does not have guidelines on excavating or collecting, but the following is suggested:

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.

2. Fossils likely to occur are for example the fossil plants from the Vryheid Formation, these are present in the grey shale (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or invertebrates from the Volksrust Formation (or any other fossiliferous layer).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) / ECO must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, fence off areas, and put the development on hold.
5. If the palaeontologist / palaeobotanist / ECO is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist / ECO will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist / ECO must do an investigation (a minimum of once a week).
8. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation guidelines during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Using Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils are visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

SAHRA Documents:

Guidelines to Palaeontological Permitting policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeotechnical Reports for all the Provinces.

Appendix 3: Listing points in Appendix 6 of the Act and position in Report.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats:
	1(n)i	"
	1(n)ii	"
	1(o)	"

	1(p)	“
D	1(h)	Figures
	1(a)i	Terms of reference
H	1(e)	Description of Methodology
	1(i)	Assumptions and Limitations
I	1(f)	Heritage value
J	1(j)	Recommendation
	1(l)	“
	1(m)	Sampling and collecting
	1(k)	“
Declaration	1(b)	Declaration
Appendix 2	1(k)	Protocol for finds
	1(m)	“
	1(q)	“