PROPOSED ESTABLISHMENT OF POLLUTION CONTROL DAMS AT TRANSALLOYS IN CLEWER NEAR EMALAHLENI (WITBANK), MPUMALANGA

# DESKTOP STUDY
# PALAEONTOLOGY

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For:

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30 June 2014

**Table of Contents:**



**List of Figures:**

# 1. Introduction

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in *i.a.* the origin of life, dinosaurs and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and to study evolutionary relationships, sedimentary processes and palaeoenvironments. The Ecca Group of the Karoo Supergroup contains a vast amount of fossil leaf imprints of plants that occurred in Southern Gondwana during the Permian. These lacustrine deposits contained plant matter which turned into coal in certain parts of the Ecca Group. The resulting coal fields form a very important mineral resource for the country.

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area which may be impacted by the proposed development.

# 2. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(4)** No person may, without a permit issued by the responsible heritage resources authority-
- (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
- (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
- (c) trade in, sell for private gain, export or attempt to export from the republic any category of archaeological or palaeontological material or object, or any meteorite; or
- (d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(5)** When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedures in terms of section 38 has been followed, it may-
- (a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
- (b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
- (c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
- (d) recover the costs of such investigation form the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

South Africa's unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage 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.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports. The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them. The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

**Scoping stage** in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial

photos , etc) to inform an  assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. A Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of 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 project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the 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 Phase 2 may be implemented.

A **'Phase 3' Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

# 3. Details of study area and the type of assessment:

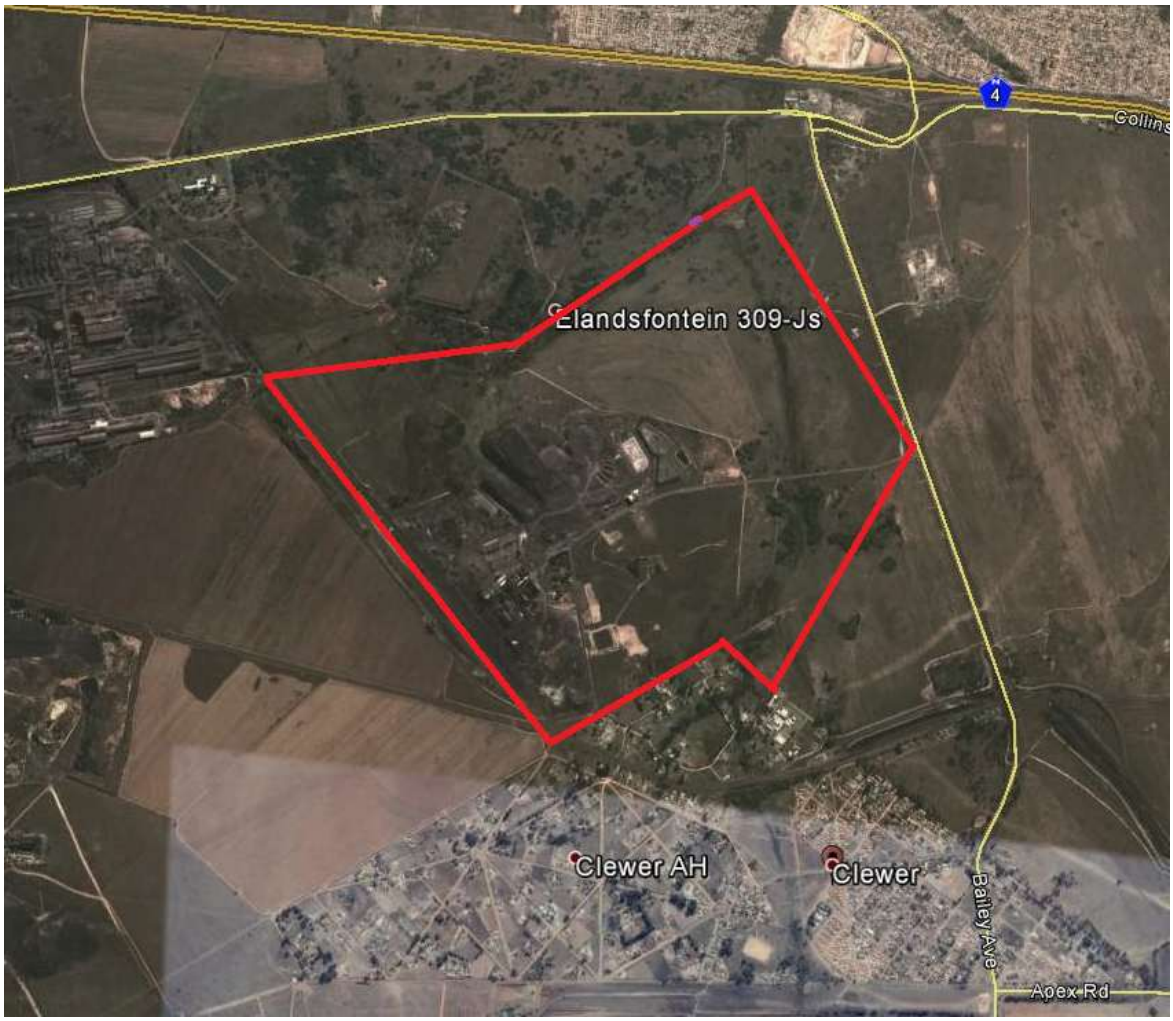


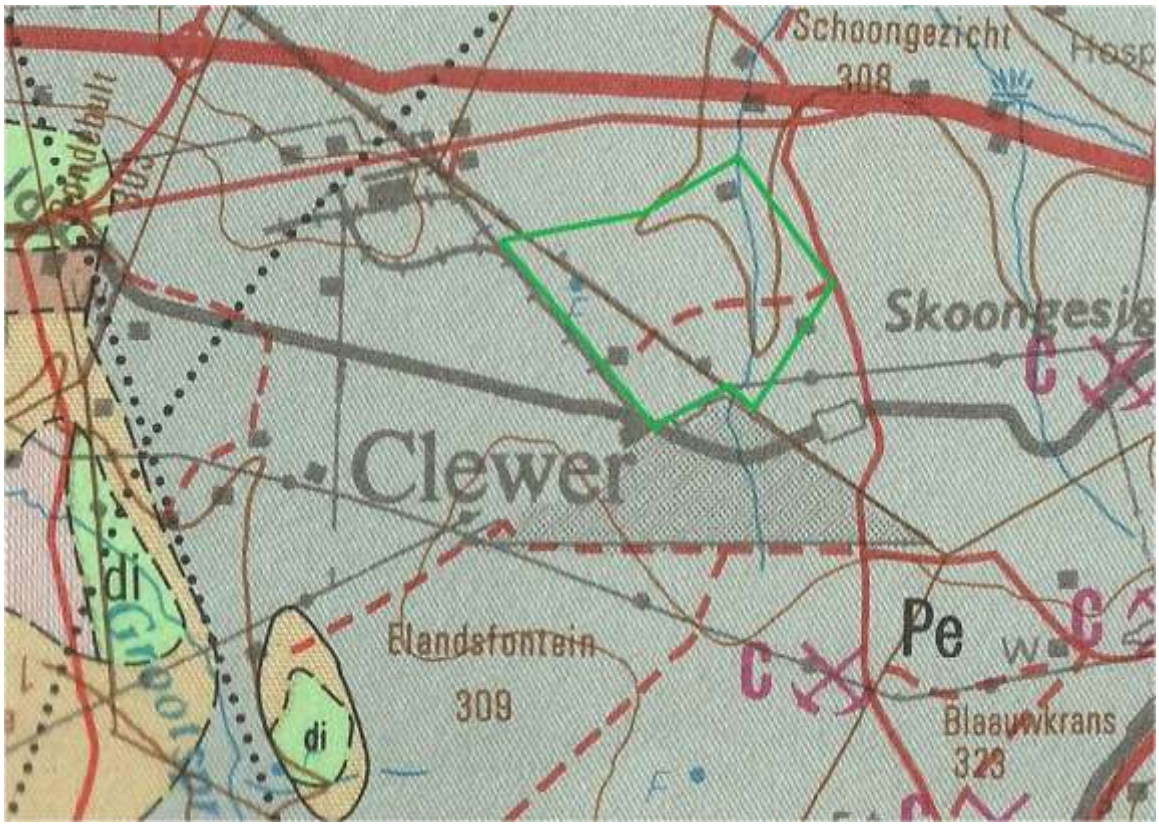

Figure 1: Google Earth photo indicating study area in the red polygon

The study area (indicated by the red polygon) is situated on the farm Elandsfontein and lies in the western part of Mpumalanga south of the N4, approximately 10 kilometers west of eMalahleni (Witbank) (see Fig. 1).

Geomorphologically the study area is characterised by a generally flat and at places gently undulating landscape consistent with the erosion of the almost horizontally orientated underlying sandstone and mudstone layers of the Ecca Group.

The relevant literature and geological maps for the region in which the development is proposed to take place, have been studied and the site has been visited on 21 June 2014 for a Desktop Study.

# 4. Geological setting




The study area is indicated by the green polygon

GEOLOGICAL LEGEND

| Legend | | |
|---|---|---|
| | **Name of geological unit** | **Map description** |
| | Ecca Group of the Karoo Supergroup | Shale, shaly sandstone, sandstone, grit, conglomerate, coal in places near base and top. |
| | Dwyka Group of the Karoo Supergroup | Tillite, shale |
| | Wilgerivier Formation of the Waterberg Group | Sandstone |
| **di** | | Diabase |
| | Silverton Formation | Shale, carbonaceous in places, hornfels and chert. |

Figure 2: Geological Map of the study area and surroundings (adapted from the 2528 PRETORIA 1: 250 000 Geology Map, Geological Survey, 1978)

The study area is dominated by sedimentary rocks consisting mostly of shale (metamorphosized mudstone), shaly sandstone, sandstone, grit, gravel and conglomerate of the Ecca Group of the Karoo Supergroup. The Ecca Group sedimentary rock overlies the shale and tillite of the Dwyka Group of the Karoo Supergroup which is exposed to the south west of the study site (Geological Survey, 1978). The Karoo Supergroup sediments were deposited in valleys and basins that existed in the pre-Karoo topography in the region. The Karoo Supergroup rocks overlie unconformably the older Waterberg Group and Transvaal Supergroup rocks (Johnson *et al*. 2009).

Five seams of coal are found in this part of the Ecca Group, four of which are of economic importance. The second from the bottom is 6m thick and is the most productive seam. The coal seams are separated by layers of shale and mudstone, many of which are fossiliferous (Johnson *et al*. 2009).

The Waterberg Group is represented by the Wilgerivier Formation in this region and outcrops to the west of the study site. It underlies the Karoo Supergroup rocks of the study site and in turn overlies the older Silverton Formation. The red to red-brown sedimentary rocks which include quartzite, grit and sandstone, which constitute the Waterberg Group, are devoid of macroscopic fossils. The Wilgerivier Formation is separated from the underlying rocks by a prominent unconformity in this region. The age of this formation is estimated at 2060-1700Ma (Johnson *et al*. 2009).

The Transvaal Supergroup is represented by the Silverton Formation of the Pretoria Group in the study area. It outcrops west south west of the study site and underlies the Karoo Supergroup rocks of the study site. The alumina, carbon and pyrite-rich shales of the Silverton Formation of the Transvaal Supergroup are devoid of macroscopic fossils. This formation which is also characterised by ripple marks was set down on the sea floor of a transgressive epireic sea. The age of the sediments which constitute this formation is estimated at approximately 2100 Ma, being younger than the underlying 2224± 21Ma Hekpoort Formation of the Pretoria Group (Burger and Coertze, 1973-1974) but older than the overlying Waterberg Group estimated at 2060Ma (Johnson *et al*. 2009).

One of the characteristic features of the Silverton Formation of the Transvaal Supergroup, which also underlies the Karoo Supergroup rocks in the study area, is the numerous diabase sills which are found within it. These diabase sills may be early differentiates of the Bushveld Igneous Complex (Geological Survey, 1978).

The study site is underlain by a layer of very fine gravel (Fig.3) and sandstone (Fig.4) which presumably overlies mudstone (not exposed in the study site) which are part of the Ecca Group.

Figure 3: Outcrop of fine grit layer at 25°53' 28.36"S 29°07' 40.51"E

Figure 4: Outcrop of sandstone at 25°53' 25.04"S 29°06' 47.23"E

Judging by the rocky outcrops in the study area, the geology consists of layers of sandstone and mudstone typical of the Ecca Group. A layer of sandston overlies a layer of weathered mudstone which outcrops to the north of the study site but is covered by deep black soil and vegetation. This layer contains an aquifer in the form of an extensive seep feeding into the wetland to the north of the study site.

The sandstone underlying the study site is probably fossiliferous but is covered with sand and vegetation. The outcrops consisting of course-grained sandstone and fine gravel did not yield any fossils however.


Figure 5: Localities of Pollution Control Dams indicated by red circles. Pollution Control Dam 1 (PCD1) has already been built

The proposed sites for the Pollution Control Dams are situated on the north east, north west and south of the plant (Fig. 5). The Pollution Control Dam 1 (Fig. 6) has already been built prior to the survey and was built on top of the geological substrate. The sites for Pollution Control Dam 2 (Fig. 7) and Pollution Control Dam 3 (Fig. 8) are covered in soil and vegetation.

Figure 6: View of Pollution Control Dam 1 site facing west


Figure 7: View of proposed Pollution Control Dam 2 site facing west

Figure 8: View of proposed Pollution Control Dam 3 site facing south

# 5. Palaeontology of western Mpumalanga

The region is fossil rich. Fossils have been found on the farms and the mines in the study area. The fossils of the region are mostly that of plant leaf imprints but silicified and coalified wood may also be found.

The study area falls within the Ecca Group of the Karoo Supergroup. The Ecca Group is renowned for its fossil content. The Ecca Group is characterized by shale, mudstone, sandstone and seams of coal (Johnson *et al*., 2006). The near horizontal layering of the geological strata and erosion of the adjacent and underlying rock strata results in a gently undulating landscape covered to a great extent by sandy soil. Exposures of the underlying geology are therefore exceptionally scarce in the northern part of the Main Karoo Basin and are mostly limited to gullies, river banks, road cuttings and the mines in the region.

The Ecca Group of the Karoo Supergroup contain vast amounts of Permian leaf imprints of plants such as *Glossopteris* in places (Kovács-Endrödy, 1991). Millions of tons of fossiliferous material yielding mostly *Glossopteris* leaf imprints have been exposed at well studied sites in the northern rim of the main Karoo Basin such as Hammanskraal (Kovács-Endrödy, 1976), Witbank (Bamford, 2004) and Vereeniging (Rayner, 1986) and the ferromanganese mine at Ryedale (Pack *et al*., 2000). Fossilised leaf imprints are not found ubiquitously throughout the Ecca Group, but in pockets such as in the Witbank area where the physical and chemical conditions during deposition resulted in the preservation of not only the structure of the leaves but also in some cases the organic material itself. The

structure of the fossilised leaves is better preserved in the shales than in the sandstone units. The leaf structures are mostly lost in the coal layers.

The rocky outcrops found in the study area consist of fine gravel and coarse grained sandstone. The sandstone overlies a layer of weathered mudstone which forms a seep which is part of an extensive wetland to the north of the study site. The mudstone has weathered into deep black soil in the seep and vlei and is overgrown by grass and sedges.

No fossils were found *in situ*. The study area is covered with sandy soil and overgrown with grass and weeds. There is a high probability that fossiliferous sandstone could be uncovered in the study area however when the soil and weathered rock are cleared for construction and the bedrock is exposed.

A rock of approximately 15 x 9 cm, consisting of layered sandstone was discovered *ex situ* in the veld east of Pollution Control Dam 1. Imprints of *Glossopteris* leaf fragments were found in the sandstone (Fig. 9). The source of the rock could not be found due to the lack of exposures in the area. The specimen was left at the offices of Transalloys for safekeeping.

Figure 9: *Glossopteris* leaf imprint in fine sandstone found *ex situ* at 25°53' 50.42"S 29°07' 27.09"E. Despite the grainy nature of the sandstone, the venation pattern of the leaf is visible.

**References:**

Bamford, M.K. (2004) Diversity of the woody vegetation of Gondwanan Southern Africa. *Gondwana Research* 7(1):153-164.

Burger, A.J. & Coertze, F.J. (1973-1974) Age determinations – April 1972 to March 1974. *Annals of the Geological Survey of South Africa*, 10:135-141.

Geological Survey (1978). *2528 Pretoria 1: 250 000 Geology Map*.

Johnson, M.R.; Anhaeusser, C.R. & Thomas, R.J. (2009) *The geology of South Africa*. Council for Geoscience.

Kovács-Endrödy, E. (1976) Notes on some *Glossopteris* species from Hammanskraal (Transvaal). *Palaeontologia africana* 19:67-95.

Kovács-Endrödy, E. (1991) On the Late Permian age of Ecca *Glossopteris* Floras in the Transvaal Province with a key to and descriptions of twenty five *Glossopteris* species. *Memoirs of the Geological Survey*, South Africa 77:1-111.

Pack, A.; Gutzmer, J.; Beukes, N.J. and Van Niekerk, H.S. (2000) Supergene ferromanganese wad deposits along the Late Cretaceous-Mid Tertiary African Land Surface, Ryedale, South Africa. *Economic Geology* 95(1):203-220.

# 6. Conclusion and recommendations:

The region is known for its fossiliferous mudstones and sandstones and it is highly probable that fossils will be encountered during construction if the excavations expose the bedrock. The potentially fossiliferous unit in the study area which may be impacted during construction consists of weathered sandstone.

Although the Ecca Group is indicated Fossil Sensitivity map as having very high sensitivity, it is indicated in the Fossil Heritage Layer Browser as having moderate significance. It is recommended that the construction is approved due to the high volume but low species diversity of the fossil material from this region and the fact that there are large and well described collections of fossil material from this region at the Council for Geoscience and at the Bernard Price Institute for Palaeontology at the University of the Witwatersrand. *Glossopteris* leaves are abundant in Ecca Group sediments in Gauteng, Free State, Mpumalanga and KwaZulu-Natal and could be considered to be amongst the most common fossils in South Africa.

Most of the geology in the study site is presently covered by alluvium and the bedrock will only be exposed during excavations. It is recommended that if the excavations for the foundations of the dams extend down into the bedrock, the potentially fossiliferous rock rubble generated be dumped in spoil heaps on the property. This will give palaeontologists with permits from SAHRA the opportunity to split the rocks at their leisure to look for fossils and collect what they need when they visit the area.

Palaeontological specialist:
**Dr JF Durand (Sci. Nat.)**
BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP), Higher Education Diploma (RAU), PhD Palaeontology (WITS)

Experience:

Palaeontological assessments:

- Urban development in Cradle of Humankind World Heritage Site (Gauteng): Letamo, Honingklip, Windgat, Sundowners, Ekutheni
- Urban development at Goose Bay, Vereeniging, Gauteng
- Upgrade of R21 between N12 and Hans Strydom Drive, Gauteng
- Vele Colliery, Limpopo Province
- 50 MW Solar Power Station, De Wildt, Gauteng
- 10 MW PV Plant Potchefstroom, North West Province
- Omega 342 50MW Solar Power Station, Viljoenskroon, Free State
- Solar energy facility at Prieska, Northern Cape Province
- Solar energy facility near Windsorton, Northern Cape
- Springfontein wind and solar energy facility, Free State
- Solar power facility, Bethal, Mpumalanga
- Diamond mine on Endora, Limpopo Province
- Development at Tubatse Ext.15, Limpopo Province
- Development at 24 Riviere, near Vaalwater, Limpopo Province
- Manganese mine south of Hotazel, Northern Cape
- Wind energy facility at Cookhouse, Eastern Cape
- Energy facility at Noupoort, Northern Cape
- Fluorspar mine near Wallmannsthal, Gauteng
- ESKOM power line, Dumo, KwaZulu-Natal
- ESKOM Gamma-Omega 765KV transmission line, Western Cape
- ESKOM 44KV power line at Elandspruit near Middelburg, Mpumalanga
- ESKOM Platreef Substation and power lines from Borutho MTS Substation to Platreef, Limpopo Province
- ESKOM Mokopane Substation, Limpopo Province

- ESKOM Aurora-Omega power line, Western Cape
- ESKOM Juno-Aurora power line, Western Cape
- Upgrading of storm water infrastructure in Valencia, Addo of the Sundays River Valley Municipality, Eastern Cape
- Development of a 10 MW Solar Energy facility on the Farm Liverpool 543 KQ Portion 2 at Koedoeskop, Limpopo Province
- Extension of limestone mine on the farms Buffelskraal 554 KQ Portion1 and Krokodilkraal 545 KQ, Limpopo Province
- Marang B - a new 3 x 500MVA 400/132kV Main Transmission Substation east of Rustenburg, North West Province

Palaeontological research:

- Gauteng: Wonder Cave
- KwaZulu/Natal: Newcastle, Mooi River, Rosetta, Impendle, Himeville Underberg, Polela & Howick Districts, Sani Pass
- Eastern Cape: Cradock District, Algoa Basin
- Western Cape: Clanwilliam District
- Free State: Memel & Warden Districts
- Limpopo Province: Nyalaland (KNP), Vhembe Reserve, Pont Drift
- Zimbabwe: Sentinel Ranch, Nottingham