Upgrading of oxidation dams, Loeriesfontein Waste Water Treatment Plant, Northern Cape Province: Palaeontological heritage impact study

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1. SUMMARY

Construction of the proposed new oxidation dams at Loeriesfontein waste water treatment plant will entail shallow excavations into potentially fossil-bearing mudrocks of the Early Permian (278 Ma) Whitehill Formation. The most important fossils likely to be found here include aquatic mesosaurid reptiles, primitive bony fishes and crustaceans. However, the overall impact of the development on the rich palaeontological resources in the Loeriesfontein area is likely to be minor, and further specialist palaeontological mitigation is therefore not recommended. Should fossil remains be encountered during excavation, the material should be safeguarded and SAHRA contacted for advice by the responsible ECO.

2. INTRODUCTION & BRIEF

The proposed development involves the building of new oxidation dams at the Waste Water / Sewage Treatment Plant about 1km north of the town of Loeriesfontein, Hantam Municipality, Northern Province (See map in Fig. 1.). The development will involve several shallow new excavations into potentially fossiliferous sedimentary bedrock of the Whitehill Formation (Ecca Group, Mid Permian Period) immediately to the west of the existing waste water / sewage treatment plant.

Since this development might affect local palaeontological resources which are protected in the RSA by the National Heritage Resources Act of 1999 (Act 25 of 1999), a palaeontological heritage impact study has been requested by SAHRA (South African Heritage Resources Agency). This study, comprising a brief field scoping study and the preparation of a technical report with recommendations, was duly commissioned by Van Zyl Environmental Consultants (Upington) on behalf of Hantam Municipality.

Fig. 1. Location of study site – a small plateau on the NW outskirts of Loeriesfontein bounded by a tributary of Kamdanie River. To the west, the dust road from Granaatboskolk runs N-S (Image from Google Earth).

3. PALAEONTOLOGICAL HERITAGE OF THE WHITEHILL FORMATION

The geology of the Loeriesfontein township area is dominated by the Whitehill Formation, a thin (*c*. 80m) succession of well-laminated, carbon-rich mudrocks of Early Permian (Artinskian) age that forms part of the lower Ecca Group (Karoo Supergroup) (Fig. 2). These Whitehill sediments were laid down about 278 Ma (million years ago) in an extensive shallow, brackish to freshwater basin – the Ecca Sea – that stretched across southwestern Gondwana, from southern Africa into South America (McLachlan & Anderson 1971, Oelofsen 1981, 1987, Visser 1982, 1994, Cole & Basson 1991, Johnson *et al*. 2006).

In palaeontological terms the Whitehil Formation is one of the richest and most interesting stratigraphic units within the Ecca Group. In brief, the main groups of Early Permian fossils found within the Whitehill Formation include:

- aquatic **mesosaurid reptiles** (the earliest known sea-going reptiles)
- rare **cephalochordates** (ancient relatives of the living lancets)
- a variety of **palaeoniscoid fish** (primitive bony fish)
- highly abundant small **eocarid crustaceans** (bottom-living shrimp-like forms)
- **insects** (mainly preserved as isolated wings, but some intact specimens also found)
- a low diversity of **trace fossils** (*eg* king crab trackways, possible shark coprolites / faeces)
- **palynomorphs** (organic-walled spores and pollens)
- **petrified wood** (mainly of primitive gymnosperms)
- other sparse **vascular plant remains** (*Glossopteris* leaves, lycopods *etc*).

Fig. 2. Well exposed sections through highly fossiliferous mudrocks of the upper Whitehill Formation to the SW of Loeriesfontein.

The Loeriesfontein area is well-known for its excellent exposures of the Whitehill Formation on hill slopes, river valleys and road cuts (Fig. 2). Important material of most of the fossil groups listed above has been collected in the vicinity of Loeriesfontein during the C20 by a series of palaeontologists (See, for example, McLachlan & Anderson 1971, Oelofsen 1981, 1987, Almond 1996, 2008, Almond & Pether 2008, Evans 2005, and refs. therein). The stratigraphic distribution of the most prominent fossil groups – mesosaurid reptiles, palaeoniscoid fishes and notocarid crustaceans – within the Whitehill Formation near Loeriesfontien (Fig. 3) has been documented by several authors, including Visser Oelofsen (1987), Visser (1992) and Evans (2005).

A detailed account of the palaeontology of the Whitehill Formation in the Loeriesfontein 1: 250 000 sheet area (modified from an unpublished account by the present author that was prepared for the Council for Geoscience, Pretoria) is presented below in **Appendix 1**. A less technical, illustrated account of the fossil biota of the Ecca Sea in general is given in **Appendix 2**.

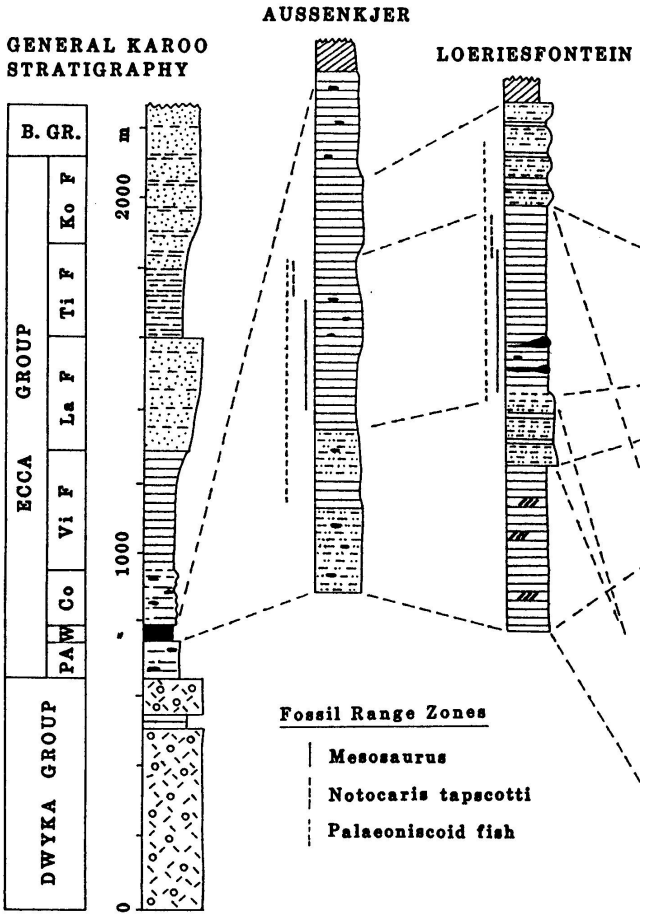

Fig. 3. Stratigraphy of the Whitehill Formation (Ecca Group) at Loeriesfontein, showing the range zones of major fossil groups (Modified from Visser 1992).

4. RESULTS OF FIELD SCOPING STUDY

A brief palaeontological scoping of the proposed development area to the west of the existing waste water treatment plant was undertaken by the author on October 11, 2008. A short summary of the main observations is given here.

The study area (c. 30º 56' 22.4" S, 19º, 26', 01.5" E) consists of a fairly level plateau at *c.* 870m asl that is bounded on the north and west by a (normally dry) tributary of the Kamdanie River and in the south by a dry stream bed (Fig. 1). Bedrock exposure on the plateau itself is very limited due to vegetation cover (disturbed succulent Karoo bossieveld, Fig. 4) and surface gravels dominated by angular clasts of grey dolomite, ferruginised mudrock (often showing a patina of desert varnish), and white calcrete or pedogenic limestone (Fig. 5). These gravels represent a *remanié* or *in situ* relictual accumulation of weathering-resistant clasts that have been concentrated at the ground surface by weathering and erosive removal of the surrounding less resistant mudrocks. The angularity of the clasts suggests that extensive water transport has not been involved here.

Fig. 4. View of study area looking south showing lack of bedrock exposure on plateau due to sparse karroid bossieveld and extensive development surface gravels.

Fig. 5. Detail of *remanié* deposit of surface gravels overlying Whitehill Formation bedrock on plateau. The gravels here consist largely of angular clasts of greyish dolomite.

Several irregular outcrops of grey dolomite showing characteristic elephant skin solution surface weathering occur towards the plateau edge. These are large lenticular dolomite nodules that typically occur within the middle portion of the Whitehill Formation in the Loeriesfontein area and elsewhere (Figs 3, 6; see also type section of Whitehill Formation given by Cole & Basson 1991). They are diagenetic (*ie* post-depositional) in origin. Similar nodules can be seen within clear vertical sections through the Whitehill Formation on river valley slopes and in road cuts respectively west and south of the study area. The nodules at the study site were examined for fossils, but none were observed (Smaller dolomitic nodules showing well-developed internal lamination have yielded unusually well-preserved, 3D crustacean remains in the Prince Albert area; Almond 1996).

Fig. 6. Resistant-weathering irregular, lenticular dolomite nodule at NW edge of plateau (Geological hammer for scale).

Fig. 7. Limited exposure of weathered shaley mudrocks of the middle Whitehill Formation exposed in small gullies at edge of plateau. Note dolomitic gravels covering upper part of exposure.

Pale grey, fissile-weathering Whitehill Formation laminated mudrocks (*ie* shales) are exposed in small dry stream gullies dissecting the edge of the plateau (Fig. 7). These were also examined for fossils, again without success. According to previous palaeontological studies in the Loeriesfontein area, these shales in the middle Whitehill Formation should contain fossil mesosaurid reptiles and palaeoniscoid fish, but lie below the acme zone (level of maximum abundance) of notocarid crustaceans that occurs high up within the mudrock interval (*eg* Oelofsen 1987, Visser 1992; Fig. 3 herein). The most detailed Whitehill section available – measured by Evans (2005) to the SW of Loeriesfontein township (probably locality WH3 of Almond 1996, at 19º 25' E, 30º 5' S) – shows the first fish fossils occurring some 7m above the top of the dolomite nodule zone. It is therefore quite possible that the middle Whitehill mudrocks affected by the proposed oxidation dam development lie stratigraphically *below* the

level of abundant fish, mesosaurid and crustacean fossils in the Loeriesfontein area, and their palaeontological sensitivity is therefore quite low.

5. CONCLUSIONS & RECOMMENDATIONS

1. The Whitehill Formation in the immediate development area is poorly exposed due to a thin cover of surface soils and gravels as well as karroid scrub. No fossils were observed within the immediate development footprint or in the wider region up to the edge of the plateau. Good exposures of the underlying Whitehill grey-weathering mudrocks (shales) and large (several m. diameter), irregular nodules of dark grey dolomite are seen however along the plateau edge bordering a deeply-incised watercourse – a tributary of the Kamdanie River.

2. Although the Whitehill Formation at Loeriesfontein is known to be richly fossiliferous, the horizon involved in this development lies stratigraphically *below* the richest fossil zone within the upper part of the formation.

3. The level of exposure of the Whitehill Formation near Loeriesfontein is unusually good at numerous other localities (including nearby stream valleys as well as steeper koppie slopes), so the impact of the proposed development on the total fossil heritage resources in the region will in practice be very minor.

4. The present oxidation dams are shallow (< 2m) and it is anticipated that only a small volume of fresh, unweathered bedrock will be excavated during the course of the new development.

It is therefore concluded that the proposed development will not have a significant impact on local fossil heritage resources which are much better developed elsewhere in the neighbourhood Loeriesfontein. No further palaeontological mitigation is therefore recommended for this project.

However, should fossils be encountered during fresh bedrock excavations made for this development, the material should be safeguarded and SAHRA contacted for advice by the responsible ECO at the earliest opportunity.

6. ACKNOWLEDGEMENTS

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