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COMPANY: Audalia Resources Limited

ATTENTION: Geoffrey Han

FROM: Graeme Campbell **DRAFT**

SUBJECT: Medcalf Project: Responses to DWER Comments re. Environmental Geochemistry of Mining-Streams Containing Vanadiferous Fe/Ti-Oxides

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Geoffrey,

The following are our responses to comments from DWER concerning potential environmental implications from the weathering of vanadiferous Fe/Ti-oxides variously contained in the mining-streams to be generated during the Project.

1.0 "POTENTIAL FOR THE RELEASE OF BIOAVAILABLE VANADIUM FROM MINE WASTE MINERALS"

A number of points were made by DWER under the above sub-heading.

1.1 Solubility & Bioavailability

DWER raise potential concerns for the deleterious formation and release of vanadate (i.e. V-oxyanion with vanadium in the pentavalent oxidation state) through photo-induced transformations of V(III) / V(IV) forms resident within crystal structures of vanadiferous titano-magnetites, etc.

In the comprehensive review by Gustafsson (2019), it is highlighted that vanadate binds to the surfaces of Fe-, Al-, and Ti-oxyhydroxides with an affinity **stronger than** that of ortho-phosphate renowned for its "fixation" by sesquioxides in Australian soils (Probert 1983).

It is noted that the research-papers provided by DWER for review focus on the 'release-to-solution' aspect of weathering of vanadiferous titano-magnetites. This is only the

'source-term' component of vanadate environmental geochemistry in a manner similar to quantifying the dissolution characteristics of phosphatic fertilizers.

However, in assessing the effectiveness of phosphatic fertilizer application for crops and pastures, the 'sink-term' is decisive is determining how much fertilizer needs to be applied, due to strong interactions of the high-affinity, poorly-reversible type between phosphate and the surfaces of sesquioxides and clays. In a similar fashion, and through essentially the same type of mechanisms (viz. chiefly ligand-exchange reactions involving surface-hydroxyl functions groups on mineral-surfaces), vanadates will be effectively "fixed" by both sesquioxides and clays which abound within the mining-streams to be generated during the Project (GCA 2020a,b).

1.2 Dust

Though difficult to quantify *a priori*, it is noted that the high SG value (*ca.* 5.0+ g/cm3) of the vanadiferous titano-magnetites will constrain their contribution to the 'dust-loading' generated during operations for the Project.

1.3 Reactive-Oxygen Species (ROS)

DWER notes that the ROS (e.g. hydroxyl radical) generation via photo-chemical reactions involving the surfaces of Fe-oxyhydroxides has potential to be harmful to plants through induced oxidation stress.

GCA notes that highly ferruginous ("red-brown") soils and duricrusts hosting vegetation rooting-zones abound within the Australian interior for a myriad of arid-land ecosystems from early in the Quaternary (0-2.5 million years bp) (Viscarra Rossel *et al.*, 2010). In this respect, the Medcalf site is thus not fundamentally different.

2.0 "RECOMMENDED ADDITIONAL GEOCHEMICAL TEST-WORK"

A number of points were made by DWER under the above sub-heading.

GCA concurs with the DWER generic comments re. undertaking weathering testwork during the active-lifetime of the Project to confirm (or refine if needed) the expectations above for the environmental geochemistry of the vanadiferous titano-magnetites variously admixed with abundant sesquioxides and clays within the mining-streams to be generated during the Project.

3.0 CLOSING

I trust the above is useful to you.

Regards,

Dr GD Campbell
Director

REFERENCES:

Graeme Campbell and Associates Pty Ltd, 2020a, "Medcalf Project: Characterisation of Mine-Waste Samples from Vesuvius, Fuji, Egmont, and Pinatubo Pits – Implications for Mine-Waste Management", unpublished report prepared for Audalia Resources Limited

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