Witness statement

NAME

Dr Rob Loch
Landloch Pty Ltd
P.O. Box 57
HARLAXTON QLD 4350

AREA OF EXPERTISE

1. I have over 45 years experience working in soil science, land management and mine site rehabilitation.

2. I am a member of Soil Science Australia, and am a Certified Professional Soil Scientist (CPSS).

3. My other academic qualifications, work experience and technical publications are set out in my curriculum vitae at Appendix A.

4. I am sufficiently expert to make this statement because I have over three decades of experience in reviewing, planning and implementing rehabilitation strategies for mine sites and disturbed lands around Australia and internationally, including three mines in Victoria.

SCOPE

5. Landloch was commissioned to undertake a rehabilitation assessment and develop a rehabilitation strategy for the Fingerboards mineral sands project environment effects statement (EES).

6. I am the principal author of the following reports:

    a) Landform, Geology, and Soil Investigation. Fingerboards Mineral Sands Project dated April 2020, which is Appendix 1 of the EES;

    b) Fingerboards Mineral Sands Project: Rehabilitation dated April 2020, which is Appendix 20 of the EES; and

    c) Two soil profile reconstruction studies, both dated April 2020, which are Appendices 21 and 22 of the EES.

7. I was assisted in preparing the reports listed above by the people listed in the following table.

Person	Company	Title	Tasks	Qualifications
T. Nash	Landloch	Environmental Consultant	Document relevant legislative guidelines, editing.	B.Env.Sc. (Hons)
Riki Lewis	Landloch	Environmental Consultant	Carry out measurements as directed	B.Sc. (Earth Sciences) M.Sc. (Earth Sciences)
P. Neale	DataFarming	Director	Preparation of maps	B.Appl.Sc. (Natural Systems)
T. Neale	DataFarming	Director	Definition of core sample intervals	B.Appl.Sc (Rural Tech.)
R. Lanagan	Kalbar Operations	Technical Adviser	Input on site geology	B.Sc. (Hons 1)

8. Where applicable, various measurements were carried out by other Landloch staff under my direction.

9. I have been instructed by White & Case, on behalf of Kalbar Operations Pty Ltd (Kalbar), to prepare a witness statement for the inquiry and advisory committee (IAC) hearing that sets out my expert views about the rehabilitation of the Fingerboards mineral sands project and responds to rehabilitation-related matters set out in the submissions on the EES. The letter of instructions from White & Case is at Appendix B. I have also provided support to Kalbar in preparing its responses to IAC questions 103, 104 and 131.

10. I adopt the reports at Appendices 1, 20, 21 and 22 of the EES as the basis of my expert witness statement and evidence.

WORK UNDERTAKEN SINCE THE EES

11. Since the release of the EES, Landloch has commenced preparation to parameterise and run the CAESAR landform evolution model for the site. Landform evolution models consider water and sediment movement on a 3-dimensional landform, enabling them to consider the formation of gullies due to concentration of overland flows, and to predict gully development over time. (They can be run for very long time periods if required, though for most minesite applications a period of 100 – 300 years is considered sufficient.) The specific value of the CAESAR model is that not only can it consider potential gullying due to flow concentrations on the rehabilitated landform, but it is also able to predict sediment movement and deposition both on and off the site. Given the community concerns with respect to sediment reaching the Mitchell river floodplain, that latter capability is important.

12. To date, initial actions to gather crucial input data for the model have involved:

    a. Engagement of a soils consultant by Kalbar Operations (in consultation with Landloch) to carry out measurements of soil infiltration capacity in both surface and subsoil horizons for a range of sites across the project area.
    b. Collection of samples of all profiles assessed and delivery to Landloch.
    c. Measurements of sediment settling velocity distributions for 18 surface soil samples.

13. Data from the field and laboratory measurements have only been received in the last week, and analysis of the data has not yet been able to be completed.

SUMMARY OF OPINIONS

Landform and soils

14. The soils report (Appendix A001 to the EES) set out to identify the soil types present and to collect sufficient information to ensure that any issues associated with rehabilitation of those soils are identified and understood. It should be noted that there has been previous large scale soil mapping in the area by the Victorian Department of Agriculture, and the conclusions with respect to soils in Landloch's report are consistent with those of that earlier work. Landloch's soils study provided sufficiently comprehensive information to enable rehabilitation options and priorities to be developed, and initial studies to be carried out.

15. The soils report does not provide a highly detailed map of soil properties – for a number of reasons. Firstly, differences between the two soil types present relate largely to subsoils, as properties of the surface horizons of both soil types are quite similar. As neither subsoil material is suitable for use in rehabilitation, detailed mapping – effectively of the unsuitable subsoils – is of little value from a rehabilitation perspective. Secondly, if mining commences, it may be up to 20 years before some areas of topsoil are stripped and used in rehabilitation. During that time, some soil properties will remain constant, but others may change. Consequently, it was recommended that more detailed sampling be carried out when topsoil is to be stripped for rehabilitation. That would ensure that fertiliser and amendment applications can be based on recent and relevant data, and tailored to each specific area being rehabilitated. (Minor variations in some soil properties are to be expected.)

16. For purposes of preparation of the project EES, the initial draft of the soils report was expanded to include some information on geology and some associated analytical data that were not commissioned by Landloch. These data were collected and provided by Kalbar Operations, and are found in sections 4.1 and 4.2, and in section 9.

17. This report is one of a large number of specialist reports prepared for the project, and reports information specific to its topic area. However, there are obvious linkages to other studies on related topics from which this document took limited information and conclusions. Specific issues linked to this report, and relevant reports dealing with those issues are listed in Section 3 of this

report.

18. Broadly, the Landloch Soils and Geology report identified consistent limitations with respect to soil productivity in terms of:
    a. Acidity
    b. Sodicity (a major issue for sodic subsoils, but with some potential to also affect surface soils)
    c. Low water holding capacity due to sandy texture of surface soils overlying either impermeable subsoil or sandy subsoil of low water holding capacity
    d. Spatially variable deficiencies in Phosphorous (P) and Potassium (K)
    e. Trace element (Boron (B) and Copper (Cu)) deficiencies.
19. Most of those issues can be addressed during rehabilitation using well-established agronomic practices, but the potential for rehabilitation works to form a more productive subsoil was identified as an opportunity to further increase soil productivity and deliver lasting benefits to grazing productivity of the project area.

Rehabilitation

Overview

20. In my experience, minesite rehabilitation varies greatly in its difficulty and cost. Greatest difficulty (and environmental risk) is associated with the presence of sulfidic materials that will generate acid mine drainage. There can also be significant challenges with specific elements (including radioactive and asbestiform materials) and with highly saline wastes. There can also be challenges in constructing and stabilising waste landforms that are much higher and steeper than adjacent natural landscapes. Local climates can be challenging for a range of reasons, including high variability in rainfall, high erosion hazard, or with low rainfall that makes vegetation establishment difficult.

21. None of the above issues apply to the Fingerboards project. There are – according to the range of expert measurements and assessments - no sulfidic or asbestiform wastes, radiation levels are low and have been assessed to be of low concern, and the wastes are not saline. The proposed re-shaped landform is not greatly different to the landform that is currently present, with no significant increases in gradients. Compared to most areas of Australia, the climate, although with some variability, is not overly erosive and with annual rainfall amounts sufficient to grow considerable vegetation cover. Consequently, rehabilitation for the Fingerboards project should be of relatively low difficulty and risk.

22. The presence of dispersive materials (specifically the Haunted Hills overburden) does present a moderate challenge. Instances of excessive erosion (tunnels and gullies) of rehabilitated landforms constructed of dispersive materials are well documented, and causes of tunnel erosion are equally well understood (e.g., Vacher et al. 2004, *Identification and management of dispersive mine spoils*, Australian Centre for Mining Environmental Research). However, where practices causing tunnel and/or gully erosion are avoided, there are many examples of successful rehabilitation of landforms where dispersive materials are placed at depth. These include coal mines in central Queensland and the Hunter Valley, and mines in the WA goldfields (e.g. Howard et al. 2010, *Ramelius Resources'*

Wattle Dam Project: Achieving bond reduction through leading practice, in Proceedings of the Goldfield Environmental management Group . 2010 Workshop on Environmental Management in Arid and Semi-Arid Areas, pp. 236-246).

23. The target vegetation is also – largely –relatively straightforward. Establishment of grazing pasture species is common in rural practice, and also in rehabilitation practice for construction and mine sites. A recent study has shown pastures established on coal mine rehabilitation in the Hunter Valley to be more productive than comparison sites (ACARP Report number C23053). There is also evidence of successful establishment of native grasslands, and numerous examples of establishment of tree species.

24. Importantly, Kalbar proposes to carry out progressive rehabilitation over the life of the project. This greatly reduces the risk of rehabilitation failure, as:

    a) Early in its life, the site will develop rehabilitation skills, trained staff, and equipment who will then be available for the life of the mine.

    b) There is potential for continuing improvement from year to year.

    c) Any occurrences of poor rehabilitation (in a given year) will affect a relatively small area, so that any necessary remediation can be carried out promptly and efficiently using trained site staff.

    d) Any necessary on-going maintenance can be carried out, largely while mining is still in progress.

    e) Levels of site disturbance at any point in time will be relatively small.

Specific strategy

25. Landloch's rehabilitation report (Appendix 20 to the EES) is not a list of prescribed, detailed actions. It recognises that there will be – over time – a range of unexpected circumstances (weather, staff and equipment issues, seed supply, etc.) that may require adaptation of plans. Equally, there should be allowance and encouragement for continuing improvement.

26. The key elements of the conceptual rehabilitation plan are to:

    a) Replace the current soils with profiles that will be more productive and resilient. (The soils currently present on the site are not highly productive, although they have supported farming for many years.) Effectively, rehabilitation will entail amendment and fertilisation of the existing surface soil, and its direct transfer and placement over a blended material that is more physically and chemically productive than the current subsoils. Initial investigations of options for a more productive subsoil material have been carried out by Landloch (Appendices 21 and 22 of the EES), and those studies are planned to be extended

to field trials, and

b) Establish revegetation zones that manage surface and sub-surface water movements to ensure ecological functionality and to largely eliminate erosion risks.

27. Importantly, there is a wide range of well-established revegetation and erosion control methodologies that can be applied where and as required.

EES and Mitigation Register

28. I was not involved in preparation of the EES document, though it naturally used the information provided in my reports. In general, the EES chapters appear to be consistent with my reports, though Chapter 11 (Closure) in referring to the soils across the area as being "similar in texture" (page 11-5, last para) should have specified "surface soils", as the subsoils actually vary greatly in texture.

29. The Mitigation Register provides a comprehensive list of the risks and mitigation measures relevant to rehabilitation works.

OTHER MATTERS

30. I am instructed that an anionic polyacrylamide (known as 'PAM') will be used as a flocculant in some processes at the Fingerboards project. PAM is widely used as a coagulant and flocculant, including for water purification plants, for flocculating sediment out of runoff from construction sites, and for improving infiltration of irrigation water into difficult soils. It is also widely used as a tackifier in hydromulch preparations. I have supervised a number of final-year research projects at the University of Southern Queensland that investigated PAM use, and a publication reporting much of that data is included in my Curriculum Vitae.

RESPONSE TO SUBMISSIONS

31. I have reviewed submissions that raise issues relating to rehabilitation and mine closure issues.

32. The submissions that I have considered are listed in Appendix C. Where the submissions raised specific technical issues that could be addressed, I have prepared responses that are also provided in Appendix C.

DECLARATION

33. I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the IAC.

Signed 

Dr Robert Loch
29 January 2021

APPENDIX A – CURRICULUM VITAE OF DR ROBERT LOCH

Academic qualifications

B.Agr.Sc. Univ. of Queensland, 1972, Major in Soil Science
B.A. Univ. of Queensland, 1978
Ph.D. Resource Engineering Dept, Univ. of New England, Armidale, 1990
CPSS (Certified Professional Soil Scientist)

Professional awards and positions

- Publication medal 1984 – Australian Society of Soil Science
- Honorary Research Consultant, Dept Agriculture, Univ. Queensland (1994 - 1999)
- Member of the Editorial Advisory Committee for the Australian Journal of Soil Research (1996-2001)
- Honorary Research Fellow, University of Southern Queensland
- President (1999-2000 FY), Qld Branch of the Australian Society of Soil Science
- Member of the CPSS (Certified Professional Soil Scientist) Accreditation Committee for Soil Science Australia (2012-2013)
- Chair of a CPSS sub-committee developing competence standards in Soil Erosion Assessment and Management for CPSS-accredited soil scientists (2012-2013)
- Member (2019 - present) of a committee developing competence standards in Land Rehabilitation as a sub-accreditation for Certified Environmental Practitioners for the Environmental Institute of Australia and New Zealand.

PROFESSIONAL CAREER

Department of Primary Industries, Queensland, 1972 – 1996. Research scientist focussing on soil and tillage management and soil erosion studies.

Landloch Pty Ltd, 1996 – present. Principal Consultant responsible for technical leadership and development, staff management and mentoring. (Landloch currently has offices in Toowoomba, Newcastle, and Perth, and erosion study facilities in Arizona and South Africa. I have worked in all Australian states and territories except Tasmania, and internationally in the Pacific, Asia, Africa, and south America.

As well as the Fingerboards project, I have worked for the following Victorian sites:

- Ballarat Gold mine (rehabilitation)
- Alcoa's Anglesea Mine (rehabilitation and closure)
- Hazelwood Mine (rehabilitation and closure)

Areas of expertise

Specific areas of expertise and experience include:

- Soil erosion measurement, prediction, and control
- Landform design for minesite waste landforms
- Soil/land/minesite rehabilitation
- Land management in agricultural/pastoral industries.

Soil erosion

I have been one of Australia's leading soil erosion researchers and consultants for over 30 years. My work and work areas include:

- Use of simulated rain to study infiltration and erosion in both field and laboratory, both nationally and internationally
- Methods for measurement of soil erodibility for a wide range of soils, wastes, and conditions
- Techniques for measuring sediment properties affecting both erosion rates and off-site movement
- Computer modelling of erosion using a range of soil erosion and landform evolution models
- Tunnel erosion assessment and control, with major emphasis on constructed landforms
- Gully erosion and control, including work in the Lower Cotter Catchment after the Canberra bushfire in 2004
- Use of rocky capping layers to control surface erosion risk
- Impacts of vegetation on runoff and erosion rates
- Acceptable rates of erosion for rehabilitated land in the Pilbara region
- Soil erosion and sediment movement on feedlots, forests, forest roads, minesites, and agricultural and pastoral land.

Minesite landform design

Developments and improvements in minesite landform began with work by myself and Professor Garry Willgoose in the late 1990's, applying erosion models to combine material and climate information to deliver more stable and sustainable landforms. This included the inclusion of natural landform elements into designs, modification of materials used in construction, and amendment of soils to provide better site stabilisation by vegetation.

In recognition of my work, I was invited to be an author of the leading practice publications:

- Mine Rehabilitation (first and second editions); and
- Progressive Mine Rehabilitation in Queensland.

Landloch clients have won industry awards for excellence in mine rehabilitation, including a Golden Gecko[1] to Minara Resources in 2008, and an Excellence Award to Cristal Mining for *Going Beyond Best Practice* from the NSW Minerals Council in 2012.

Soil/land/minesite rehabilitation

I have been widely involved in promoting the importance of characterising mine wastes and topsoils to enable better management. This includes the amendment of acidic and dispersive soils and wastes, and the use of fertilisers to restore depleted/degraded soils.

I also carried out studies of soil changes following rehabilitation, and of the importance of those changes in achieving a stable, sustainable final ecosystem.

Landloch staff (under my supervision) regularly provide analysis and recommendations for the management of soils from a wide range of mining, construction, and infrastructure projects.

As well, Landloch staff (under my supervision) have carried out assessments of minesite rehabilitation success across a wide range of sites over the last 15 years, meaning that I have had extensive experience in assessing the success or failure of rehabilitated sites, and in the factors governing success.

I have also been involved in a number of river reach studies considering riparian zone condition and potential for additional works to enhance ecological function.

Land management under agricultural and pastoral uses.

I grew up on a farm in the eastern Darling Downs, Queensland, and have been involved with agriculture throughout my professional career. I currently own and operate a small farm on the Darling Downs, growing crops and grazing cattle, and have wide experience with planting grain, fodder, and pasture crops and managing grazing animals through a range of seasonal conditions.

Training and webinars

I regularly provide industry training, presentations to conferences, and – more recently - webinars to various interest groups.

Webinars that I have presented recently include:

- *Stable landforms, fire, and recovery – a workshop for the Gippsland region*. Organised by Federation University Australia, Gippsland Campus , September 3, 2020.
- Workshop session on *Expert perspectives – lessons learned*, presented to *Expert Witness Masterclass*, organised by Environmental Institute of Australia and New Zealand, September 4, 2020.
- *Planning minesite landforms: making the most of opportunities to reduce costs and difficulty*. Joint presentation with Evan Howard (Landloch) to BHP's international closure, planning, and engineering groups. October 28, 2020.
- *Risk Management of Hydromulched Slopes*. Organised by The Australasian Chapter of the International Erosion Control Association, October 29, 2020.

[1] Western Australia's leading mining environmental award

- *Validating landform designs for Progressive Rehabilitation and Closure Plans: which model is appropriate for your site?* Joint presentation with G. Sharp (Landloch) to meeting of the Central Queensland Mine Rehabilitation Group, 19 November, 2020.

Publications related to areas of expertise/experience

Soil erosion

Loch, R.J. (1996). Using rill/interrill comparisons to infer likely responses of erosion to slope length. Implications for land management. *Australian Journal of Soil Research* 34: 489-502.

Loch, R.J., Slater, B.K., and Devoil, C. (1998). Soil erodibility (K) values for some Australian soils. *Australian Journal of Soil Research* 36: 1045-1056.

Costantini, A., **Loch, R.J**., Connolly, R.D., and Garthe, R. (1999). Sediment generation from forest roads: bed and eroded sediment size distributions, and runoff management strategies *Australian Journal of Soil Research* 37: 947-964.

Loch, R.J., Espigares, T., Costantini, A., Garthe, R., and Bubb, K. (1999). Vegetative filter strips to control sediment movement in forest plantations: validation of a simple model using field data. *Australian Journal of Soil Research* 37: 929-946.

Loch, R.J. (2000). Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu Mine, Tarong. *Australian Journal of Soil Research* 38: 299-312.

Loch, R.J., Connolly, R.D., and Littleboy, M. (2000). Using rainfall simulation to guide planning and management of rehabilitated areas: II. Computer simulations using parameters from rainfall simulation. *Land Degradation and Development* 11: 241-255.

Loch, R.J. (2001). Settling velocity – a new approach to assessing soil and sediment properties. *Computers and Electronics in Agric*. 31: 305-316.

EJ Howard and **RJ Loch** (2019). Acceptable erosion rates for mine waste landform rehabilitation modelling in the Pilbara, Western Australia. In Mine Closure 2019 - AB Fourie & M Tibbett (eds), ISBN 978-0-9876389-3-9 © 2019 Australian Centre for Geomechanics, Perth.

Vacher, C.A., **Loch, R.J**., and Raine, S.R. (2004). Identification and management of dispersive mine spoils. Final Report Project **R54,** Australian Centre for Mining Environmental Research.

Minesite landform design

Hancock, G.R., **Loch, R.J.**, and Willgoose, G.R. (2003). The design of post-mining landscapes using geomorphic principles. *Earth Surface Processes and Landforms* 28: 1097-1110.

Loch, R.J. and Vacher, C.A. (2006*). Assessing and managing erosion risk for constructed landforms on minesites*. Proceedings Goldfields Environmental Management Workshop 2006, Kalgoorlie-Boulder.

Loch, R.J. and Lowe, S.M. (2008). *A logical framework for design, construction, and rehabilitation of minesite waste rock dumps.* A. Fourie (Editor), Proceedings of the First International Seminar on the Management of Rock Dumps, Stockpiles, and Heap Leach Pads, 5-6 March 2008, Perth, Australia, pp 257-265, Australian Centre for Geomechanics.

Loch, R.J. (2010). Sustainable landscape design for coal mine rehabilitation. Final report, ACARP Project C18024 (Australian Coal Association Research Program).

H. Squires, M. Priest, I. Sluiter, **R. Loch** (2012). *Leading practice waste dump rehabilitation at the Ginkgo mineral sands mine*. In Mine Closure 2012 — A.B. Fourie and M. Tibbett (eds) © 2012 Australian Centre for Geomechanics, Perth, ISBN 978-0-9870937-0-7

Soil/land/minesite rehabilitation

Loch, R.J. and Orange, D.N. (1997). Changes in some properties of topsoil at Tarong Coal – Meandu Mine coalmine with time since rehabilitation. *Australian Journal of Soil Research* 35: 777-784.

Loch, R., Stevens, T., Wells, G., and Gerrard, R. (2006). Development of key performance indicators for rehabilitation, Murrin Murrin Operation. Fourie and Tibbett (Editors), Proceedings of the First International Seminar on Mine Closure, 13-15 September 2006, Perth, pp. 569-576, University of WA.

Loch, R.J., Vacher, C.A., and Lowe, S.M. (2008). Topsoil organic carbon and nutrient considerations for waste dump rehabilitation. Proceedings, Goldfields Environmental Management Workshop, 2008, Kalgoorlie, pp. 102-108.

Loch, R.J. (2016). *Function and performance targets in ecological rehabilitation*. In Mine Closure 2016 – AB Fourie and M Tibbett (eds), © 2016 Australian Centre for Geomechanics, Perth, ISBN 978-0-9924810-4-9

R J Loch and E J Howard (2018*). Material characterisation – avoiding unnecessary costs and failures*. In From start to finish: a life-of-mine perspective, AusIMM

Polyacrylamide research

Vacher, C.A., **Loch, R.J**., and Raine, S.R. (2004). Effect of polyacrylamide additions on infiltration and erosion of disturbed lands. . *Australian Journal of Soil Research* 41: 1509-1520.

APPENDIX B – INSTRUCTIONS FROM WHITE & CASE

WHITE & CASE

15 September 2020

White & Case
Level 32, 525 Collins Street
Melbourne VIC 3000
Australia

GPO Box 2756
Melbourne VIC 3001
Australia

T +61 3 8486 8000

ABN 17 847 592 731

whitecase.com

Rob Loch
Landloch Pty Ltd
PO Box 57
Harlaxton, Queensland 4350

By email: lochr@landloch.com.au

Confidential and subject to legal professional privilege

Dear Mr Loch

Fingerboards mineral sands project

We act as legal advisors to Kalbar Operations Pty Ltd (**Kalbar**), the proponent of the Fingerboards mineral sands project (**Project**).

This letter confirms and sets out the scope of your retainer to prepare an expert witness statement and potentially also present evidence at the inquiry hearing to be held in relation to the environment effects statement (**EES**) prepared for the Project pursuant to the *Environment Effects Act 1978* (Vic).

1. The Project

Kalbar proposes to develop the Project on an area of approximately 1,675 hectares within the eastern part of the Glenaladale mineral sands deposit in East Gippsland, Victoria. The Project site is located near the Mitchell River, approximately 2 km south of Glenaladale, 4 km south-west of Mitchell River National Park and 20 km north-west of Bairnsdale.

The Project includes the development of an open cut mineral sands mine and associated infrastructure. It is expected to have a mine life of 15–20 years and involve extraction of approximately 170 Mt of ore to produce approximately 6 Mt of mineral concentrate for export overseas.

2. Panel and EES inquiry

The EES and the studies and assessments that underpin it (together with a draft planning scheme amendment and application for an EPA works approval) are presently on public exhibition until the end of October 2020.

The inquiry is scheduled to convene its directions hearing on 13 November 2020, and the inquiry hearing is scheduled to commence on 7 December 2020. We will keep you informed of any relevant directions, including the timetable for filing evidence and, if required, any expert conferences.

3. Scope

This letter is confirmation of your engagement as an independent expert to:

(a) prepare an expert witness statement in which you:

(i) set out your background and relevant expertise;

15 September 2020

(ii) briefly describe and summarise the Rehabilitation report prepared in support of the EES and your role in preparing it. In particular, we ask that you detail whether there is anything in the report that you disagree with or wish to elaborate on and set out any additional information that you consider necessary to include, including any additional assumptions;

(iii) consider the submissions that are relevant to your area of expertise and respond to any issues raised; and

(b) if required, prepare and present expert evidence at the inquiry hearing.

We will provide further instructions on the scope of your engagement and any new instructions as necessary.

4. Form of your expert witness statement

The form and content of your expert witness statement should be prepared in accordance with Planning Panel Victoria's *Guide to Expert Evidence* (**Guide**). We enclose a copy of the Guide for your reference. Please review the Guide and ensure your witness statement addresses the matters set out in it, in particular those matters listed under the heading 'The expert witness statement'. Please contact us if there is anything in the Guide that you do not understand, or if you have questions in relation to it.

Until your expert witness statement is in final form it should not be signed. You should, however, be aware that unsigned documents may need to be disclosed to other parties.

5. Your duties and responsibilities as an expert witness

Even though you are engaged by Kalbar, you are retained as an expert to assist the inquiry, and you have an overriding duty to it. The inquiry will expect you to be objective, professional and form an independent view as to the matters in respect to which your opinion is sought.

6. Timing

The timing for completion of your expert witness statement is to be advised. We will let you know as soon as we can.

7. Conflict of interest

It is important that you are free from any possible conflict of interest in providing your advice. You should ensure that you have no connection with any potential party to this matter that could preclude you from providing your opinion in an objective and independent manner.

15 September 2020

8. Costs and invoicing

Landloch will continue to be contractually engaged by Kalbar and Kalbar will continue to be responsible for the payment of your fees. Your accounts should be sent directly to the appropriate person nominated by Kalbar.

9. Confidentiality

Your engagement and any documents you prepare under it should be marked "Confidential and subject to legal professional privilege".

If anyone other than ourselves, Kalbar or its technical advisers contact you about this engagement or the work you are undertaking under this engagement, please contact us immediately.

If you have any questions about this letter or require any additional information, please contact us.

Yours sincerely,

Tim Power

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Partner

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Enc: Planning Panel Victoria's *Guide to Expert Evidence* - April 2019

APPENDIX C – RESPONSE TO SUBMISSIONS

Submissions Reviewed

No.	Town	Dwelling ID
054	[redacted]	
079		
268		
355		
423		
429		
442		
488		
502		
506		
534		
546		
552		
568		

712	[redacted]	
716		
744		
745		
763		
766		
777		
781		
812		
813		
837		
849		
875		

SOILS AND REHABILITATION ISSUES RAISED AND RESPONSES PROVIDED

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
552	Issues R1 & R2, Table 3, page 12	*The mixing of soils to achieve desired outcomes has only (to date) been demonstrated in theory and laboratory scale tests.* Include a requirement for the proponent, to the satisfaction of regulators, to: 1. design, conduct, monitor, and evaluate a program of field scale trials, as soon as any approval is granted; and, 2. develop a mass balance of the ingredients for the proposed soil mixture(s) for each stage of mining, based on the learnings from the trials, to demonstrate that the recommended soil mixture(s) can actually be manufactured in sufficient volumes at each stage of rehabilitation. 3. include (as a minimum), field rainfall	1. Field trials are planned and, I understand, likely to commence in the near future. 2. Mass balances are an obvious requirement for mine planning that should follow on from the field trials. 3. Such trials have been planned, but have been delayed by COVID 19.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		simulation trials to enable calibration of landform evolution models.	
552	Issue R3, Table 3, page 12	The actions described in Actions R1 and R2 (above), are required to address this issue also.	As above
552	Issues R8 & R9, Table 3, page 13	*Inadequate treatment. Tunnel erosion has been identified in this area (in similar terrain) extending up to 8 metres depth. (Reference A, (Sec 7))* Soil treatment and mitigations to reduce the risk of tunnel erosion be required to extend to a depth of 8 metres.	The citation suggesting that tunnel erosion extends up to 8m in depth in the Fingerboards area is not supported by the reference cited. The reference states: a) *"The spatial distribution of the tunnel erosion was determined in the Bairnsdale region with two different types, paddock and escarpment, identified."* b) Paddock tunnelling "*was relatively shallow (within 1 to 1.5 metres of the soil surface) and generally found in multiple occurrences."* c) Escarpment tunnelling "*has been identified on the escarpments of the Gippsland Lakes and major river frontages and is characterised by deep erosion (up to 8 metres) and occurs less frequently than paddock tunnelling."* There are obvious technical reasons why tunnelling would occur at greater depths on escarpments (deeper, unstable layers being exposed on the scarp face). But there are not (and will not be) any scarps (cliffs) on the Fingerboards site. Potentially unstable layers will not be exposed on valley sideslopes. Consequently, this latter and relatively restricted form of tunnel erosion is highly unlikely to occur in the area.
716B	Soils, dot point 1, page 4	No detailed map of Australian Soil Classification (ASC) soil types or recommended stripping depths of soil types. "Mixing" of different soil type topsoil	In this case, clear identification and delineation of locations of the two soil forms was not considered to be of value for soil management for rehabilitation, as: • In both soil forms, the subsoil was of low chemical and/or physical fertility, and was not planned to be recovered for placement in rehabilitation operations; and • The surface soil (A horizon) was broadly consistent in texture and chemical fertility across both soil forms, and would be stripped to either

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
	Soils, page 4	and subsoil during reinstatement-rehabilitation is a key risk. Different soil types (i.e. soil units) should be stripped and stockpiled separately for reinstatement as per the "original" soil type. A map of ASC soils types within the project area and also recommended topsoil and subsoil stripping depth should be developed.	300 mm or to the depth of either gravel or heavy clay B horizon, which ever was encountered first. Limiting stripping of surface soil to a depth of 300 mm was recommended, as deeper soil (irrespective of texture) is low in nutrients and organic matter, and of no greater value for rehabilitation purposes than the subsoil material options currently being researched. There is no intent or requirement to reinstate the original soil type.
716B (SLR)	Section 2.4 Adequacy of identified future EPR – Rehabilitation p23	Closure criteria – the following are considered relevant to the proposed performance criteria and associated monitoring/measurement:	
	Dot point 1, p23	Carrying capacity measurement is not included for grazing land.	Landloch's rehabilitation report specifically refers to pasture productivity as a rehabilitation/completion target, and there is specific reference to comparison with reference (analogue) sites.
	Dot point 2, p23	Auditing for post mining land use compliance is applicable to progressive rehabilitation and not just at end of mine life.	Agreed.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
	Dot point 3, p23	Comparison to pre-mining information for land capability etc. is not identified while the pre-mining or better condition is the target.	See above
	Dot point 5, p24	Site contamination assessment is not considered or related to progressive rehabilitation should it be required based on incidents, historic or recent land use impacts etc. prior to undertaking progressive rehabilitation of relevant areas.	Where/when incidents occur, such assessments would undoubtedly be initiated. There is currently no indication (to Landloch's knowledge) of any potential contaminants.
716B (SLR)	Section 2.5 Recommendations – Land use, dot point 1, p26	Analyse end of pot trial subsoil samples for arsenic and Add certificate of analysis showing As results.	Subsoil arsenic (As) concentrations were not measured as they would – due to mixing – have ranged from zero to about 33 mg/kg. This is very much lower than the HIL A (Health Investigation Level A) level of 100 mg/kg, and the important point is that that level refers to surface soil, not subsoil. Arsenic in plant material was measured simply to confirm that As is a non-issue.
716B (SLR)	Section 2.5 Recommendations – Land use, dot point 2, p26	100% coarse tailings treatment was indicated to be analogue for the subsoil currently on site. Further discuss the basis for this comparison.	The comment did in fact refer to the podosol soils on site, which are of low chemical fertility, but have potential for root expansion to depth. Agriculture Victoria reports – for a podosol – rooting depth of 70 cm, and water holding capacity of 52 mm. With fertilisation, this soil could potentially be more productive than sodosols due to slightly higher water holding capacity, and less potential for waterlogging. In contrast, Agriculture Victoria reports – for a sodosol at Fingerboards – a rooting depth of 35 cm, Plant Available Water of 47 mm, and low nutrient holding capacity in the surface soil.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
			Actual water holding capacity of the coarse tailings is slightly lower than that shown for Podosol soil at depth, but, because the Podosols tend to have significant content of rock and gravel at depth (up to 30% approximately), effective water holding capacity would be reduced to be very similar to that of the coarse tailings.
716B (SLR)	Section 2.5 Recommendations – Land use, dot point 3, p26	Use of several options subsoil combinations for different areas of rehabilitation. When and where to use which combination or what criteria to use to select which combination to use is not described. Addition of table showing each option with advantage and disadvantage of each and criteria of where the use of this combination is most suitable would be of benefit.	At this stage, options are still being investigated, with a field trial including a range of subsoil options planned for the coming year.
716B (SLR)	Table 3 Soil Investigation – row 5, p58	Total phosphorus doesn't tell us what is actually available for plant uptake. The Bray Phosphorus test (for acidic soils) would have been a much more accurate determination of available phosphorus.	I have two responses to this submission: (a) Given the need to consider long-term sustainability of rehabilitated sites, the total amount of Phosphorous (P) present is actually of greater meaning than available P. (b) There will be regular and more detailed sampling and analysis of soil properties when mining commences and soil stripping is being planned, with such analysis including available P (using a test method consistent with local agronomist usage)..

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		Comment: Re-test samples if possible	
716B (SLR)	Table 3 Soil Investigation – row 6, p58	Suggest including a recommendation for weed control to be undertaken in the years prior to topsoil stripping to decrease available weed seed bank (ideally weed control is undertaken from 2020 onwards). *Comment: Add in weed control recommendation*	Actions to reduce weed seed burden in stripped topsoil could be very helpful. I am not sure whether access to appropriate areas would be possible once mining commences, but I would recommend its consideration.
716B (SLR)	Table 3 Soil Profile Reconstruction – row 1, page 58	Subsoil constructed from different combinations of coarse (sand) tailings, fine tailings, HHF gravel overburden, HHF sand overburden. Limitation of fine tailings is given as elevated arsenic (As). 97% of dry matter intake of As by grazing animals may be via soil ingestion. 20cm topsoil will be placed over subsoil. Subsoil exposure not taken into consideration. Arsenic analysed only in plant material and not end of trial soil.	There will be field trials in the coming year that will use constructed subsoils, and there is potential for measurement of arsenic (As) in both subsoil and plant material in those trials. (Levels of As are low, and placement of fine tailings at depth means that potential for plant uptake is extremely low and unlikely.)

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		Comment: Analyse end of pot trial subsoil samples for arsenic.	
716B (SLR)	Table 3 Soil Profile Reconstruction – row 3, page 58	Detection limit of arsenic analysis (5 mg/kg) is less than the guideline value used for comparison of data (4.5 mg/kg (dry weight) European Commission 2002)	Yes, by 0.5 of a mg/kg – a very small margin.
716B (SLR)	Table 13 Rehabilitation Technical Review, last row, p 100	Section 5.7 Limiting Soil Factors for Site Rehabilitation notes that preliminary soil analysis [topsoil] shows despite considerable variation in properties, there are a number of inherent constraints to plant growth that occur sufficiently consistently to be considered characteristic of the site. *Comment: Research will be needed to identify appropriate materials for subsoil replacement, and to identify amelioration requirements and practices to ensure suitable "subsoil" performance.*	Field trials planned for the coming year

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
716B (SLR)	Table 13 Rehabilitation Technical Review, row 2, p 101	Appendix A001: Landform, Geology and Soil Investigation Section 11.3 *Comment: The report states no requirement for restriction of stockpile height when retained for less than 4 months; however, the Guidelines for environmental management in exploration and mining Section 3.2.6 notes stockpiles "…should be low (generally less than 2m in height), gently battered and located away from drainage lines."*	I agree that it would be helpful to ensure that runoff/sediment from stockpiles is directed away from drainage lines.
813	Soils – Cursory proposal lacking detail, paragraph 3, page 45	Risk factors within the report have been consistently under-estimated. "At this stage it is not anticipated that erosion will be a major risk …" One can only assume that this statement refers to the proponent's assumption? The local agricultural landholders	My assessment of erosion risk is based on some 40 years of experience in erosion research and assessment and my inspection of the Fingerboards area, and specifically considers: • Site gradients, which will be no steeper (generally) than those currently present and stable; • Establishment of vegetation cover equal to or greater than that currently present; • The relatively low erosivity of the prevailing climate; • Elimination (at least in the short term) of grazing pressure and disturbance from steeper areas and flow lines; and • The relatively low erodibility of the sandy soils present.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		with extensive, long-term knowledge and experience of the local soils are very confident that erosion will indeed be a certain and major risk. What will be done if the proponent's "anticipation" is wrong and erosion is, as local knowledge has determined, a major risk?	Because rehabilitation will proceed progressively, there will be time and opportunity for rehabilitation practices to evolve and for any repairs or remediation that may become necessary to be carried out. It has been noted that for the higher risk areas – steep outer faces and major flow channels – a range of options for erosion control during vegetation establishment are readily available and have been widely used across Australia, including application of hydromulches with tackifiers, surface stabilisation compounds, compost blankets, and (in channels) strategic placement of rock. Adoption of one or more of these methods is likely to be guided by a combination of risk assessment (considering gradients and slope lengths) and experience.
813	Soils – Cursory proposal lacking detail, paragraph 4, page 45	No meaningful targets have been set. What is the target Olsen P for 12 months after fertiliser application? What is the target for top-soil organic matter? What testing for soil biological activity will be undertaken? What will be the consequence should the proponent fail to meet these non-existent targets?	Such targets will be set once the mine receives approval and begins operation. It was stated (Section 11.1, para 5 – Landloch Rehabilitation document) that: "*Analogue/reference sites will be established as part of the rehabilitation monitoring program to help form a baseline and define target values that will be used to assess the success of the rehabilitation effort (Tongway and Hindley 2004). Analogue sites will be established outside of the mining footprint area for all the vegetation associations planned to be removed and reinstated."*
813	Soils – Cursory proposal lacking detail, paragraph 5, page 45	In section 11.5.1 it states "Species mixes for pasture areas should be developed on the basis of local experience and	I agree about the importance of local knowledge and experience in developing rehabilitation plans. This is why planned field trials of rehabilitation are being informed by advice from local agronomists.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		knowledge." [emphasis added]. This statement is problematic. Just from which local experience does the proponent intent to draw? Based on previous and current experience with "consultation" the knowledgeable locals won't talk to the proponent anymore.	
813	Lack of understanding of agriculture, paragraph 1, page 46	In many locations throughout the EES documents statements are made similar to that on page 27 (Landloch, April, 2020) "These soils are clearly not suitable for agriculture,…". There are approximately 170 years of evidence that refute this. Many generations of families have been successfully raised on productive farms within the proposed project area. This casts doubt on the report author's experience with agricultural soils, and	The full text referred to is "*These soils are clearly not suitable for agriculture, and are likely to be of low-moderate productivity only for grazing uses."* The text makes a distinction between agriculture (growing crops) and pastoral or grazing use. There are no cultivated paddocks in the Fingerboards project area, evidence that the soils are not suitable for sustained cropping. However, I do not dispute that farms in the area have been productive and viable over many years.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		consequently on any conclusions they draw from the soil unsuitability assumption.	
813	Irrigation and Dams, paragraph 1, page 46	The author states that "Intensive agriculture/horticulture is present to the north-east of the project area, on the deeper and more fertile soils of the floodplain of the Mitchell River, but not within the project area", page 28 (Landloch, April, 2020). Firstly, what and where is the proponent's definition of "intensive grazing"? Secondly, why was this inappropriate assumption made?	Note that the usage of "agriculture" in the report specifically does not refer to grazing. Unfortunately, the report did not include a strict definition of intensive agriculture, though most people would consider intensive agriculture to refer to high value and high frequency cropping, generally with irrigation.
813	Irrigation and Dams, paragraph 2, pages 46 & 47	Intensive grazing on irrigated pasture occurs at both the Eastern and Western ends of the proposed project area. At the Eastern end is a beef and wool/lamb producer irrigating his land with water pumped from the Mitchell River. At the Western end of	Virtually any soil – if irrigated and fertilised – can be highly productive. But for dryland use, soils with highly limited nutrient and water storage capacity are not. So, unless there is tangible probability that the Fingerboards plateau will be irrigated in the future, in my view the assessments in the EES correctly characterised the Fingerboards soils as being "*of low-moderate productivity only for grazing uses."*

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		the project area is a dairy, grazing pastures irrigated from dams they have constructed. Both these properties demonstrate that, with appropriate management, soils within the proposed project area are capable of supporting highly productive and intensive forms of agriculture.	
813	Soil testing inadequate – biased sample area, paragraph 1, page 47 Soil testing inadequate – biased sample area, paragraph 2, page 47	Testing of the soils within the proposed project area was undertaken. Some of the methodologies of the sampling are disturbing. Most of the soil samples were taken in the North Eastern quadrant of the proposed project area, with the majority taken from the property of a "lifestyle" owner. Unsurprisingly, this property displayed many signs and symptoms of a lack of management and a proper grasp of	There seems to be a lack of understanding of the difference between a soil survey and a detailed agronomic assessment. The soil assessment did not aim to provide detailed spatial and quantitative information on soil properties, fertility, amendment and fertiliser requirements across the project area. As significant portions of the project area may not be disturbed for 10 or 20 years (and the project has yet to be approved), more detailed sampling would realistically and reasonably be done on an annual basis to assess the coming year's rehabilitation needs when mining commences. Soil surveys typically identify the soils present (and their distribution) and provide some information on typical soil properties – often for only one or two profiles for each identified soil type. Soil surveys use a combination of observation pits or sites and a small number of analysed profiles. In this case, the site had previously been mapped by Agriculture Victoria at 1:100,000 scale, so the intent of Landloch's investigation was to confirm the soil types already known to be present, and to provide greater analytical data on the soils to provide broad guidance for rehabilitation planning. (From the soil

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		agriculture. On the basis of results from this particular property, generalisations appear to have been made for the entire project area, including those farms under high levels of management.	properties identified, it became obvious that accurate mapping of soil type distributions was not necessary, as: • In both soil forms, the subsoil was of low chemical and/or physical fertility, and was not planned to be recovered for placement in rehabilitation operations; and • The surface soil (A horizon) was broadly consistent in texture and chemical fertility across both soil forms, and would be stripped to either 300 mm or to the depth of either gravel or heavy clay B horizon, which ever was encountered first. Sonic core data and auger holes were used to provide observations, with the auger holes providing greater coverage of the site. The sonic cores were used to provide a relatively high density of analytical samples. Most conclusions that were reached were not based on soil properties that would be affected by property management. The soil types present are such that their properties could have been reasonably accurately predicted without analysis. Equally, the Landloch soil report quite specifically notes the levels of variation found, and recommends more detailed sampling when rehabilitation works commence.
813	Soil testing inadequate – biased sample area, paragraph 3, page 47	Section 5.4.1 refers to the "core sampling density." However this is only relevant if the sampling is evenly distributed throughout the area. In this situation the sampling is highly concentrated within one area of the proposed project and sparse in other areas. This results	As the overall sampling/observation density included the auger holes, the spread of observations, although somewhat concentrated in the middle third of the project area, does provide reasonable coverage of the Project site. This is because: • The area had been mapped previously; and • Soils will be sampled in greater detail when rehabilitation works commence. In my view, the potential for "inaccurate data and meaningless results" is minimal.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		in generalisations and inaccurate data and produces meaningless results.	
813	Soil testing inadequate – biased sample area, paragraph 4, pages 47 & 48	Why are soil test results that disagree with the averages gained from the North Eastern quadrant of the proposed project area apparently set as the 'benchmark' dismissed as "local variations"? This would seem to indicate a lack of rigour in the testing and analysis, as more extensive testing may well suggest the "local variations" are more universal than is accepted in the document.	Comment not clear
813	Soil testing inadequate – biased sample area, paragraph 5, page 48	When soil tests are undertaken for agronomic purposes, a transect is walked across the selected paddock and samples taken at regular intervals. Between 20 and 30 samples are taken per	Not relevant and incorrect. Firstly, a detailed "agronomic" assessment is not in my view required at this time, as significant portions of the project area may not be disturbed for 10 or 20 years, and the project has yet to be approved. Secondly, the highest density of (soil) sampling that is used in precision agriculture (for high value cropping) is one surface sample per 2 – 4 ha, and that density would not be considered for grazing land (where returns and costs per hectare are much lower).

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
	Soil testing inadequate – biased sample area, paragraph 6, page 48	paddock using a standardised sample corer (generally to a standard depth of 10cm) (Agriculture Victoria, 2020), with the sampling sites selected to avoid "extreme" sites within the paddock, e.g. high nutrient areas such as gateways, stock camps and water points. Over the proposed project area this means that several thousand samples would be required – not the trivial 27 non-standard samples (of which 7 were rejected) [page 19] (Landloch, 2020). As the sampling sites were not selected in the usual manner, and the samples themselves were taken with very non-standard technique, there is considerable doubt as to the validity of the results.	

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
813	Wrong test for available P, paragraphs 1 & 2, page 48 Wrong test for available P, paragraphs 3, 4 & 5, pages 48 & 49	The report specifies the tests used to characterise the fertility of the soil, including testing for Phosphorus (P). Two tests were undertaken to determine levels of Phosphorus, a Total Phosphorus test and a Colwell Phosphorus test (Colwell P) to determine the level of Plant Available Phosphorus. It is interesting that the Colwell P test was chosen as "In Victorian pasture soils, plant-available phosphorus is usually tested using the Olsen P test and results are presented in milligrams per kilogram (mg/kg) or parts per million (ppm)." (Agriculture Victoria, 2020). The Colwell P test has not been in standard use in grazing areas in Victoria for many years.	An agronomist is typically interested in available Phosphorous (P) because it's what will be used by a crop or pasture in the next few months. However, for rehabilitation planning purposes, my interest was in growth of plants over the next 50 or 100 years – and for that, the total soil reserve of P has more meaning. It's also a good indicator of the soil's ability to accumulate and retain nutrient stores, which is essential information in building an understanding of the soil and its long term function. However, when planning specific rehabilitation works to be carried out in the relatively near future, available P would be measured and considered. The germinating plants generally need a "starter" application of a range of nutrients to ensure rapid establishment and surface stabilisation. The Colwell P measurement mentioned in the soil report was essentially an artefact of the standard soil fertility analytical suite applied to the samples. Olsen P has been used in subsequent soil sampling and analysis, with subsequent sampling likely to use which ever test of available P is used by local agronomists.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		Throughout the report the author does not make much reference to the results of the Colwell P tests, but instead focusses on the Total Phosphorus test results. "Most phosphorus is tightly held by soil minerals and weakly available to plants, so testing for available phosphorus is more useful than total phosphorus" (Soil Quality Pty Ltd, 2020). Total Phosphorus test results are unhelpful in determining soil fertility as the relationship between Total Phosphorus and Plant Available Phosphorus (as measured with the Olsen P test) is highly complex and dependent on a range of factors such as, but not limited to the: level of biological activity within the soil, forms of P historically applied, soil	

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		pH, level of standing dry matter, degree of cover with litter... Agronomists do not make pasture species or fertiliser recommendations based on a Total Phosphorus test result. They will insist on a Plant Available Phosphorus test result; that is, an Olsen P.	
813	Wrong test for available P, paragraph 6, page 49	Impacts of the 2014 bushfire and the extended drought have not been taken into account when interpreting the results. Both these events have significantly disrupted the mineral cycles and levels of biological activity within the soil, and would therefore impact on the results.	This may well be the case, and is a good illustration of why detailed assessment of soils to be rehabilitated should not be carried out until close to the time when soil stripping and rehabilitation is due to occur. By that time, there may – or may not - have been other events of significance that will affect the soils and influence the rehabilitation approach and methods.
813	Wrong test for available P, paragraph 7, page 49	The lack of concern regarding the delay between the soil sampling and the laboratory analysis is both worrying and of	Organic Carbon (OC) and Total N are important, and there was no intent to suggest otherwise. Again, because Organic Carbon can vary through time in response to drought and fire, it is important that such measurements be made close to the time when soils are to be stripped and revegetated.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		major importance. "Because of the length of time that some samples were stored prior to sub-samples being taken and analysed, data potentially impacted by prolonged microbial decomposition (Organic Carbon and Total Nitrogen) were not considered in subsequent data interpretation." Page 20 (Landloch, 2020). This provides the reader with the impression that the delay was unimportant as organic carbon and nitrogen levels are insignificant, when in fact they are of considerable import.	
813	Wrong test for available P, paragraphs 8 & 9, page 49	The importance of soil organic matter and soil organic carbon is so high that the local Better Beef Network is holding an entire series of workshops over the next year to educate its members. One of the	Agree on importance of Organic Carbon. But, as noted previously, it was strongly recommended that such measurements be made close to the time when soils are to be stripped and revegetated. It was not recommended that they be ignored.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		topics is "Increasing water holding capacity and drought resilience with soil carbon". How can this unorthodox and lackadaisical management and analysis of the soil samples, which brings the other results into question, be acceptable? Is there a clear and documented chain of custody for the samples?	
813	Definition of Top Soil, paragraphs 2 & 3, page 49	Within the proposed project area, as identified within the EES document, the A horizons are relatively shallow, approximately 50-100m thick. Most of the fertility, organic matter and biological activity occur in the top 25-50mm of the soil. The subsoil below this is relatively infertile and lacking biological activity and organic matter. Local farmers avoid tilling the soil deeply to	The more detailed topsoil stripping recommendation provided is: *The surface soil (A horizon) was broadly consistent in texture and chemical fertility across both soil forms, and would be stripped to <u>either</u> 300 mm <u>or to the depth of either gravel or heavy clay B horizon, which ever was encountered first</u>. Limiting stripping of surface soil to a depth of 300 mm was recommended, as deeper soil (irrespective of texture) is low in nutrients and organic matter, and of no greater value for rehabilitation purposes than the subsoil material options currently being researched.* (my underlining) Local farmers would have learnt not to till - in part - because every tillage operation would cause a surge in biological breakdown and loss of organic matter. (Decay constants for organic matter are much higher in sandy soils.) Dilution would be of relatively less impact, as plant roots rapidly reach the depth of tillage and below and access nutrients in the tilled zone.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		avoid mixing this infertile subsoil with the fertile topsoil as it would reduce the overall fertility. The proponent's consistent use of the term topsoil to describe the top 300mm of soil is inaccurate, misleading and has led to erroneous conclusions.	In general, levels of organic matter and fertility within the "topsoil" layer are planned to be addressed by: a) Addition of organic matter to the rehabilitated soil surface; and b) Addition of chemical fertilisers. Often, the most effective way to replace soil organic matter is to grow it.
813	Impact of Organic Matter and vegetative cover, paragraphs 1 & 2, pages 49 & 50	Limitations in the Available Water Capacity of the soil were identified within the EES report as a major limiting factor for pasture production within the proposed project area. This statement is repeated in many ways in various sections of the report, and is emphasised in Figure 30. The statement is usually accompanied by another stating that this will be remedied in the rehabilitation process by	Low available water capacity (AWC) of soils in the Fingerboards area is also noted in the report by Agriculture Victoria: http://vro.agriculture.vic.gov.au/dpi/vro/egregn.nsf/pages/eg_soil_bairnsdale_dargo For the sodosol (even with relatively high organic matter in the surface), low AWC is reported and largely attributed (by Agriculture Victoria) to a very shallow rooting depth, as the dispersive clay B horizon is largely impermeable to roots. For a podosol, AWC is similarly reported as low, with comment that such soils have very low nutrient holding capacity and are considered infertile. Landloch's report makes similar comment. There has been no suggestion (to my knowledge) of mixing fine tailings into the topsoil. For both soils, formation of a subsoil that that is permeable to plant roots and capable of holding more water and nutrient is an obvious way to address the limitations of the local soils

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		mixing some fine tailings in with the top-soil to improve the Water Holding Capacity. These claims are of concern given that the level of soil organic matter (OM) was not measured.	
813	Impact of Organic Matter and vegetative cover, paragraphs 3 & 4, page 50	"In all texture groups, as OM content increased from 0.5 to 3%, AWC of the soil more than doubled. Soil OM is an important determinant of AWC because, on a volume basis, it is a significant soil component." (Hudson, 1994). Not only is organic matter significant for increasing the water holding capacity of the soil, but the influence of other factors such as litter and vegetative cover in increasing soil biological activity and water infiltration and reducing run-off have not been considered.	See above. Potential impacts of organic carbon on soil structure and ability to retain nutrients are also important for rehabilitation success and sustainability, and it is planned to add organic material to topsoils as part of revegetation works. I'm not able to find a statement that "runoff from the project area will remain constant" – and particularly not for a situation where topsoil and vegetation is removed. The Landloch Rehabilitation document did include some water balance modelling to compare impacts of differing vegetation forms on different soils, but those simulations did not purport to predict runoff from the site during mining. They were used simply to gain a better appreciation of the potential responses to changing vegetation and soil.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		Run-off from the project area is assumed to remain constant [page 71 (Landloch, April, 2020)] despite the removal of top-soil and all the associated grasses and other vegetation.	
813	Impact of Organic Matter and vegetative cover, paragraph 5, page 50	Figure 30 (Landloch, 2020) is used to demonstrate the lack of the water holding capacity of the soil to support plant growth during the drier months. Figure 30 compares the daily pan evaporation rate with the monthly rainfall average. The data used is stated to be from the Bureau of Meteorology (BoM) Lindenow weather station. However the BoM Lindenow weather station does not report Pan Evaporation figures; it only reports rainfall. Where do the Pan Evaporation figures come from, and why are they not acknowledged?	Figure 4 in Landloch's soils report refers to: • BoM Monthly Pan Evaporation Gridded Data for the site (-37.787711, 147.33622); and • BoM Monthly rainfall data for 85050 Lindenow (-37.8010, 147.4578), ~11km from the site (-37.787711, 147.33622). The source for this information is acknowledged in the report.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
813	Impact of Organic Matter and vegetative cover, paragraph 6, page 50	Some of the properties within the proposed project area have been in the same families for many generations, in some cases since the 1850s. These families have long term rainfall records which show that there are major variations in rainfall patterns across the proposed project area. Reliance on the rainfall records for Lindenow is of doubtful relevance. It is interesting that reference is not made to the closer weather station on the Mitchell River at Glenaladale.	For rehabilitation purposes, precise data on rain and evaporation is not essential. There will be both temporal and spatial variation, but the key is to deliver soil preparation and seeding methods that achieve the best possible result across that variation.
813	Impact of Organic Matter and vegetative cover, paragraphs 8 & 9, pages 50 & 51	Seasonal variations in soil moisture content are usual, expected and compensated for in a managed agricultural system. There are many strategies for managing periods of variable grass growth throughout the year across the seasons and also during	The Reports note that there will be periods of soil moisture stress in summer. They do not suggest that grazing cannot occur.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		unexpected climatic events and anomalies. These vary from the traditional forms of fodder conservation such as the production of hay and silage, drawing on supplementation to utilise dry standing feed and less palatable species, employing variable grass recovery periods, adjusting stocking rates as well as growing summer and winter active crops. To suggest that the variations in soil moisture content at Glenaladale are too great to support agriculture is to imply that there are only one or two pockets of high rainfall across Australia where agriculture should be practiced. Glenaladale has one of the more benign climates and seasonal variability of	

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		the agricultural regions within Australia.	
813	Mixing Fine Tailings into top-soil, paragraphs 1 & 2, page 51	In order to increase the soil's water holding capacity, the proponent suggests that a proportion of the fine tailings be mixed with the top-soil. It is suggested that this "… will induce a degree of drought proofing" [page 49 (Landloch, 2020)]. Increasing clay content means that when the soil dries out it is harder, and more difficult to wet. This in turn leads to increased run-off flow over the soil surface during heavy rainfall events, and consequently more erosion.	There is no suggestion or proposal, to my knowledge, that tailings will be mixed with surface soil.
813	Mixing Fine Tailings into top-soil, paragraphs 3 & 4, pages 51 & 52	The stockpiling of "top soil" results in a significant loss of organic material and biological functionality within the soil; this then reduces the water holding	For much of the life of the mine, there will be direct transfer of soil from where it is stripped to the area being rehabilitated. Stockpiling will only occur in the first 2-3 years. To the best of my knowledge, there is no intent to mix topsoil and subsoil.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		capacity and infiltration rates of the soil. As referred to previously, the "top soil" referred to throughout the document is inaccurate and misleading. The proponent's use of the term topsoil refers to the top 300mm of soil, not the fertile and biologically active A horizon of the soil profile more accurately referred to as top soil. The mixing of subsoil with the genuine topsoil dramatically alters the soil properties and creates the need for amendment.	
813	Mixing Fine Tailings into top-soil, paragraphs 5 & 6, page 52	The proponent has ignored the high levels of toxic metals (Chromium, Vanadium, Tungsten, Thorium and Uranium) contained within the tailings shown in Figure 23 (Landloch, 2020) and Table 9 (Landloch, 2020), for which there are no	Again, to the best of my knowledge, there is no intent to mix tailings with topsoil.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		HIL A levels. These are all airborne carcinogens. Where there are no appropriate Australian Standards then World's Best Practice must be adopted. This is usually accepted as those of the United States of America's Environmental Protection Authority. Following mixing of these elements with the topsoil, any disturbance which creates dust will cause health impacts throughout the region. There is no mention of using alternative or more appropriate standards within the EES.	
813	Solution not satisfactory = Unfit for purpose, Unsustainable final landscape, paragraph 1, page 52	In order to prevent Tunnel Erosion, the proponent is suggesting a number of mitigation measures that may be possible. The term 'may' is concerning as it does not produce confidence and/or surety that the suggested actions will be	The specific actions outlined are: *Soil profile development and vegetation establishment for the plateau top landform zone have been specifically planned to:* • *Reduce surface runoff by increasing plant growth and surface vegetation cover;* • *Maximise water use by plants by increasing soil water storage in the profiles and increasing tree density slightly; and*

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		actually implemented, possible, effective and/or sustainable over the long-term. These 'may be possible' options are: • Establishment of deep rooted plants • "Treatment" of the top 1m of the subsoil • Creation of a smooth landform to prevent water infiltration into the deeper subsoils.	• *Minimise drainage to depth by increasing profile water storage and tree density.* *Where material likely to disperse (such as HHF overburden or fine tails) is placed as part of a constructed subsoil, gypsum will be applied in sufficient quantity to reduce exchangeable sodium and magnesium to acceptable levels (ESP <4 and Ca/Mg ratio >0.5) over a depth of at least 500mm. With placement of a 300 mm deep topsoil layer over the constructed subsoil, that should give an effective rooting depth of at least 800 mm.* *Spatial variations in vegetation are targeted to minimise any seepage flows reaching the valley slopes and channels by increasing the density of deep-rooted species (trees and shrubs) in those areas (Figure 16). Consequently, potential for any seepage flows to exit in those areas is minimised, and the geotechnical stability of the slopes will be increased by presence of a higher density of deep-rooted species.* I am not sure of the source of the statements that are raised by this submission, but the above remains my opinion and recommendation.
813	Solution not satisfactory = Unfit for purpose, Unsustainable final landscape, paragraph 2, page 52	The establishment of deep rooted plants (such as trees) to absorb water and prevent it infiltrating into the subsoils may eventually become effective, but only in a number of decades. How much erosion will occur before the trees grow?	With trees likely to reach 6 m height by 7 years old (Fagg 1987), it could be expected that by the end of the 20-year mine life, there will be considerable water extraction by deep roots at that time. As the areas within which trees would be established will also be seeded to grass, surface cover should develop rapidly, and surface erosion in areas with establishing trees should be minimal within a few months of grass establishment. If tunnel erosion is going to develop, it is, in my experience across a number of sites, more likely to be noticeable within several years rather than 20. Tunnel erosion invariably is caused by ponding of significant volumes of water (several

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
			to tens of cubic metres) directly over a dispersive layer. So if tunnel erosion occurs, it should be within the mine life and able to be treated by the mine. The photographs below shows very typical development of tunnel erosion where large volumes of water are ponded by a horizontal berm.  Fagg (1987). Establishment and Early Growth of Indigenous Eucalypts Sown on Forest Sites Infested with Phytophthora cinnamomi in East Gippsland, Australia *Forest Ecology and Management*, 20 (1987) 53-78
813	Solution not satisfactory = Unfit for	Treatment of the still-to-determined depth of the 'top' of the subsoil is	Deep drainage will always occur. It undoubtedly happens now. But treatment of the subsoil will ensure drainage occurs more evenly and less frequently.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
	purpose, Unsustainable final landscape, paragraph 3, page 52	problematic for a variety of reasons. There is no assurance that this will occur, as the proposed treatment "requires research". IF a treatment is successfully developed, it is still not a viable and sustainable solution as it will not prevent water infiltrating into the lower subsoil.	
813	Solution not satisfactory = Unfit for purpose, Unsustainable final landscape, paragraphs 4, 5 & 6 pages 52 & 53	Disposal of the tailings has been shown (Daniels W, 2003) to create an impermeable layer along which the water will flow. Soil cracking, wombats, rabbits and tree roots all will create holes in the "shell" of treated subsoil, allowing the water and dispersed clays to exit, creating tunnels. Eventually these tunnels will develop to the point where they will "blow-out", producing a stream of highly turbid mud combined with any	If the fine tailings are not placed within proximity (50 metres, say) of the plateau edge, which is the case for the Fingerboards project, this scenario becomes irrelevant.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		contaminants from the tailings with which they have been in contact. This event may not occur quickly; but experience from the previous local tunnel erosion remediation project shows it will happen. The proposed "mitigation measure" is a band-aid solution to defer the issue until the proponent has left. The landholder and/or taxpayer would be left with the repair costs.	
813	Solution not satisfactory = Unfit for purpose, Unsustainable final landscape, paragraphs 7 & 8 page 53	On the basis of a so-far non-existent soil treatment the remainder of the solution relies on leaving a perfectly smooth landscape to avoid ponding, thus preventing water seeping into the subsoil and creating the conditions for tunnel erosion. The proposal suggests "… it is likely that the majority of fine	This submission misinterprets the recommendation with respect to ponding. Generally, the ponded volumes that cause tunnel erosion are in the order of several cubic metres to tens of cubic metres – not a matter of a few litres. (See photo shown previously) Settlement – if it occurs - is an issue that will be addressed, in part because of Landloch's strong recommendation to avoid having areas where significant volumes of runoff are retained. (Rehabilitation report, Section 7.5.8, first paragraph.) The comments with respect to settlement are based on analysis by a geotechnical engineer (T.R. Osborne, report dated 12/09/2019), but I recommend that their accuracy be reviewed.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		tailings settlement will have occurred by the time rehabilitation works are carried out, and subsequent further settlement may not be large." [emphasis added] page 45 (Landloch, April, 2020), and that the landscape then be filled and smoothed over. Locals know that the creation of a smooth landform with gradual slopes to prevent ponding and hence water infiltration into the deeper subsoils is not achievable. "…it is planned that rehabilitated slopes will not carry any water-retaining or ponding features, thereby eliminating the key driving force for tunnel erosion to develop." [emphasis in the original], page 69 (Landloch, April, 2020). This "solution" is very	In practice, areas of significant ponding (cubic metres of water) are an extremely common causes of tunnel erosion. Identification and elimination of such areas is a very effective first step in remediating the problem.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		clearly unsustainable in any time-frame.	
813	Solution not satisfactory = Unfit for purpose, Unsustainable final landscape, paragraph 9 page 53	What if local conditions cause the subsidence to take several years, rather than the 12 months suggested? How is the landscape going to be maintained in a condition which prevents ponding? There has been no consideration of wombats and how much damage they cause. Will farmers be banned from taking vehicles into the area – because vehicles create tracks which cause ponding? Will all forms of animals be denied access because they create impressions in the ground which create ponding? What happens in several decades when the planted trees finally grow and then start to fall over?	This submission underestimates the volume of ponding required to cause tunnels. The rehabilitation report does not recommend that vehicles and animals cannot use the rehabilitated area. There would – obviously – be some restriction on anyone driving directly up a steep slope during the early stages of vegetation establishment, as in those cases the wheel tracks very commonly give rise to rills or gullies. But apart from that, there is no logical reason for restriction of vehicle or animal movement once the soil consolidates under vegetation. Generally, animals do not like to have burrows inundated as a result of overland flows, so they tend to dig them such that water does not flow in. It would be unusual for planted Eucalypts to blow over in several decades. But such depressions would be of minimal concern if the exposed subsoil has been treated during placement as part of rehabilitation works and is both non-sodic and non-dispersive.
813	Solution not satisfactory = Unfit for	The terms "likely" and "may" do not inspire confidence. Experience	The risk of settlement would be evaluated over the 20-year life of the mine and suitable solutions developed and implemented – if needed – in accordance with the Project's rehabilitation plan.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
	purpose, Unsustainable final landscape, paragraph 10 page 53	from the Douglas Mineral Sands Mine is that further settlement can be large. A landowner there has described how he found he was unable to use his boom-spray on "rehabilitated" paddocks due to the high levels of settlement. What will the proponent do when they find these statements are in error? What are the impacts and consequences for the landscape, rivers and Gippsland Lakes should these "possible" solutions not be effective? The risk cannot be appropriately evaluated now on a future "may".	
813	Solution not satisfactory = Unfit for purpose, Unsustainable final landscape, paragraph 11 page 53	If the subsidence is complete within 12 months and if the proponent returns to smooth out any ponding areas, the "rehabilitated" landform will still not be stable or sustainable.	As noted earlier, the volumes of water required to initiate tunnels are larger than assumed in this submission.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		Wombat holes and rabbit warrens create ponding, vehicle traffic creates ponding, trees falling over create ponding, and livestock traffic and resting create ponding areas. The landscape described would require an unsustainably high level of on-going maintenance and be totally unsuitable for the land's prior agricultural usage.	
813	Road Pillars, paragraphs 1, 2, 3 & 4, page 54	Roads are an aspect of the project that will have major implications for erosion. The roads and the construction of the corresponding impermeable "Road Pillars" will create the ideal conditions for erosion. It is interesting that the proponent plans to use the Haunted Hills Formation Gravels for the Road Pillars given they have acknowledged they are dispersive and "No compaction trials	Assumptions of continuity of impermeable layers are not correct.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		have been carried out to determine shear strengths of reworked and compacted gravels" [page 82 (Mining One Consultants, 2020)]. Rainfall and dust suppression water run off impermeable road surfaces. The road run-off (and any other surface run-off) is concentrated by the impermeable road pillars and infiltrates to the dispersive subsoil. When the water encounters a lower impermeable layer, such as tailings, the water then flows along the impermeable layer until it finds a route to release the hydrostatic pressure (e.g. ground cracking, tree roots, wombat holes …). The water flow then transports the dispersed soil, increasing suspended solids in the	

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		waterways and creating very deep tunnels. The dispersive soils will be at highly increased risk of erosion as their normal levels of structure and compaction will have been destroyed by the mining process. The kinetic energy of water forming these tunnels should not be underestimated – it will effectively have a pressure head of the depth of the mine, i.e. 40m head of pressure or approximately 400kPa. This effect was demonstrated clearly during the East Gippsland Tunnel Erosion project. Tunneling exacerbated by a road culvert required excavation to a depth of 6m before it could be backfilled and treated. This instance of erosion consisted of two levels of tunnels, with	

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		subterranean "waterfall" linking the levels.	
813	Tunnel Erosion within the proposed project area, paragraph 1, page 54	The author of the report appears unaware that tunnel erosion occurred in the project area within a "swale" described as "unlikely to erode", and was treated as part of the local tunnel erosion remediation project. The tunnel erosion treatment, which comprised of the application of gypsum, use of an excavator to dig-out and refill the tunnels followed by the entire mini-catchment being deep ripped to a depth of 1.5 m, had a very limited level of success. This suggests that solutions to the issue of tunnel erosion are considerably more difficult, and vastly more expensive than the proponent currently believes.	I am aware of the local tunnel remediation project, and of the technical reasons why its treatments could not be expected to be highly successful. The amounts of applied gypsum were too low, and application to the surface when trying to treat a soil layer at ≥1 metre depth has little chance of achieving the necessary mixing and change in soil properties when ripping at 1 metre spacing. Application of treatments to minimise tunnel erosion is much more effective and cheaper when constructing a soil profile from the bottom up and mixing ameliorants into the layers as they are placed, rather than attempting to apply treatments to the surface of an existing profile.
813	Control of surface erosion	The author places a great deal of emphasis on the	I am a co-author of the paper quoted in this submission, so I am very familiar with it.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
	paragraphs 1, 2 & 3, page 55	use of the Revised Universal Soil Loss Equation. This is a simplistic modelling of a very complex process. "Although there has been widespread use of various factors from the revised universal soil loss equation (RUSLE) (Renard et al. 1997), caution is advised in the application of that model, as it gives average erosion rates for a slope only and gives no information on peak erosion rates that may develop at points along a slope. Other models are under development and trial, but potential users of any model should consider: • whether the model has been validated and the level of accuracy demonstrated • the availability of accurate and appropriate input data (preferably directly measured)	The complete model was not used – only its length/slope (LS) factor, which integrates potential impacts of slope gradient and length on erosion. Input data for estimation of LS factors was available and accurate, and the factor is quite applicable for demonstrating potential impacts of any changes in landform between original and post-mining.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		• the applicability of the model to the situation of interest." Page 22, (Commonwealth of Australia, 2016). None of the suggestions in the above reference appear to have been followed. These precautions apply to all the models used throughout the EES, which have been influenced by lack of local validation, inaccurate input data and lack of consideration as to the applicability of the model.	
813	Drought & Bushfire impacts have not been considered, paragraphs 1, 2 & 3, page 55	Two key factors which have not been considered in the EES reports are the impacts of the 2014 Mt Ray bushfire and the most severe and longest drought (three years) ever experienced in both East Gippsland and Victoria. Both drought and fire result in the	See previous response about bushfires and droughts. As soils will be assessed over the life of the mine, the point of this statement is not clear. There will be annual assessments of: • Analogue sites • Rehabilitated sites • Soils planned to be stripped in the coming year. If soil condition "improves" during a run of good seasons, that will be noted and addressed as appropriate in planning for rehabilitation, as will any deterioration in condition over a run of dry seasons or due to a bushfire. What was initially measured or observed is neither final nor fixed.

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		creation of bare ground and reducing vegetation mass, providing the impression of "poor" agricultural practice. The author comments that "Visually, the soil/grazing system in, and adjacent to the project area does not appear to be achieving high productivity, with low levels of biomass and signs of overgrazing", page 50 (Landloch, 2020), but fails to put this lack of bio-mass into the context of the bushfire and the following drought – all within a six year period. The situation has been misunderstood and the landholders appear to have been considered responsible for nature's vagaries. It should be noted that a key management	

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		strategy during drought is to reduce livestock numbers. This reduces the impact on the land from the stock, and reduces the fodder expenses for the land manager. Outside observers would only see the low stock numbers and reduced biomass, without understanding the context of the observation.	
813	Questionable statements, paragraphs 1 & 2, page 57	These are scattered throughout the EES documentation. Some examples are: • The conclusion that "texture contrast soils are largely associated with plateau tops…" page 22 (Landloch, 2020) doesn't appear supported by samples. • "Top soils throughout the project area are typically sandy, acidic and generally infertile." page 23 (Landloch, 2020) is not supported by our	Comments with respect to the soils are quite consistent with conclusions reached for the same soils by the Agriculture Victoria soil survey, which was led by one of Victoria's most respected soil scientists, the late Dr Ian Sargeant: http://vro.agriculture.vic.gov.au/dpi/vro/egregn.nsf/pages/eg_soil_bairnsdale_dargo

Submission number	Location in submission	Issue/concern and "Recommended Action"	Response
		successful food production industries. •"…rates and durations of fertilizer addition do not appear to have been high." page 25 (Landloch, 2020). On what basis has this conclusion been drawn and which properties are being referenced? Many of these viewpoints are unsupported by data which ignore the context of the observation. These perspectives appear to be intended to cast doubt as to the viability of the existing food production industries and to minimise the apparent impacts of the proposed project. What they achieve is to throw doubt on the credibility of the author.	