
# EXPERT WITNESS STATEMENT OF

# MR DARREN BILLINGSLEY

## FINGERBOARDS MINERAL SANDS PROJECT EES

## 29 JANUARY 2021

PREPARED FOR:

**INQUIRY AND ADVISORY COMMITTEE**

**EXPERT OF KALBAR OPERATIONS PTY LTD**

*SGS is the world's leading inspection, verification, testing and certification company. Recognised as the global benchmark for quality and integrity, We provide **innovative** services and **solutions** for every part of the environmental industry. Our global network of offices and laboratories, alongside our dedicated team, allows us to respond to your needs, when and where they occur.*

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**Prepared for**

**Inquiry and Advisory Committee**

***This report is approved by***

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Mr. Darren Billingsley
Senior Health Physicist

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### REPORT CONTENT

## 1. NAME AND ADRESS

1.1 Principal Senior Health Physicist:

Mr Darren Billingsley
Senior Health Physicist
SGS Australia Pty Ltd
10/585 Blackburn Road
Notting Hill, VIC 3186

## 2. QUALIFICATIONS AND EXPERIENCE

2.1 I have more than 30 years' of knowledge in the health physics industry, with extensive experience in the environmental radiation field, and on industrial work sites. Experience includes radiation monitoring and the provision of advice to the mineral sands, uranium mining, and oil and gas industries; and other sectors.

2.2 Refer to Appendix A for full details of qualifications and expertise.

## 3. SCOPE

### Instructions

3.1 White & Case, as legal advisors to Kalbar Operations Pty Ltd (Kalbar), engaged me to prepare this expert witness statement and potentially present evidence at the inquiry hearing.

The engagement letter is provided in Appendix B.

### Role in preparation of the EES

3.2 SGS Australia Pty Ltd were engaged to prepare a Radiation Assessment Report (RAR) for the Fingerboards Project in East Gippsland, Victoria, as required for the Environment Effects Statement (EES). The report (titled 'Radiation Assessment Report, April 2020') was exhibited

as Appendix A011 of the EES and was prepared for the purpose of addressing all radiation related aspects of the EES scoping requirements.

3.3 My role as Senior Health Physicist with SGS was to undertake all aspects of the works including a radiation baseline site assessment, radiation dose estimations, assessment of impacts, and prepare the RAR.

3.4 In accordance with the EES scoping requirements, the EES needs to address radiation implications and issues for the Project. The key objectives for the radiation assessment included:

- Characterisation of background radiation levels within the project site and the broader project area;
- Assess the likely radiation effects on the workforce, members of the public, and the environment associated with the project during operations, rehabilitation, decommissioning and post-closure; and
- Identify mitigation measures to avoid, reduce and/or manage any significant effects for sensitive receptors arising from adverse changes to the background radiation levels in the vicinity of the project (including the radionuclide content of vegetation, surface water and groundwater).

3.5 I have adopted the RAR as the basis of my expert witness statement and evidence, subject to corrections and additional information collected following completion of the RAR noted in Part 4 of my Statement.

**Other persons who assisted**

3.6 Persons who assisted with the completion of the RAR were:

- Mr Christian Curtis-Wilson (Senior Health Physicist, SGS)
  – assistance with baseline survey, and deployment of additional radon monitoring stations
- Mr Simon Toomey (Consultant Health Physicist, SGS)
  – review of report iterations.
- Mr Stephen Rutkowski (Senior Radiochemist, SGS)
  – advice on laboratory radioanalytical techniques including limits of detection
- Mr Jake Thunder (Field Technician, Kalbar) and Mr Matt Golovanoff (Geologist, Kalbar)
  – with direction from SGS, collection of samples additional to those obtained by SGS during the May 2017 baseline survey including:
    - surface and subsurface soils (RAR, Section 5.2)
    - surface water and groundwater samples (RAR, Section 5.5 and 5.6)
    - change-out of passive radon dosimeters (RAR, Section 5.8)

## Methodology

3.7 To the best of my ability I have responded to all of the radiation related issues raised in the EES submissions.

3.8 The RAR remains the main source of information for this statement and is regularly referenced.

3.9 A full list of references used for the RAR are listed in Section 16 of that report. Additional references not listed, and or documents referenced directly in this Statement, are provided for convenience:

- EGI 2020. Environmental Geochemistry International (EGI), 2020. *Geochem Testing of Fingerboard Tailings and Overburden*. Memorandum prepared for Kalbar Operations Pty Limited. April 2020. (referenced RAR, Section 9.2.7)
- Kalbar Operations Pty Limited 2020. *EES Geochemistry and Mineralogy Summary Report*, April 2020. (RAR, Section 5.2, and 6.4)
- Mineral Technologies 2017. Mineral Technologies, *Kalbar Operations Pty Limited. Fingerboards Mineral Sands Project, 'Wet Process Flowsheet Testwork on a 10 Tonne Sample'* Report No.: MS 17/83258/1, November 2017. (referenced RAR, Section 6.4 and 9.1.2)
- Katestone Environmental Pty Ltd 2020. *Stage Two Air quality and Greenhouse Gas Assessment for the Fingerboards Mineral Sand Project*, April 2020. (referenced RAR, Sections 5.7, 9.2.1, 9.2.3, and 9.3)
- IAEA 2010. International Atomic Energy Agency, *Handbook of Parameter values for the prediction of radionuclide transfer in terrestrial and freshwater environments*, Technical Report Series No. 472, 2010. (referenced RAR, Sections 5.2, 5.3 and 9.2.3)

3.10 In addition, I have had regard to the following other documents in preparing this statement:

- *Proposed Expansion of the ANRDR to the Mineral Sands Mining and Processing Industry*, ARPANSA Technical Report No. 165 (2014)
- Hydorflux email 27/11/20. *Email from Mitchell Hastings, Hydroflux to Chris Cook, Kalbar sent on 27/11/20 re filtration capabilities of DAF*
- Technical Note 1: *Implementation of centrifuges for water recovery and tailings management*, 18 January 2021.

3.11 I have reviewed submissions on the EES relating to radiation and radioactivity and my response to these submissions are set out in Section 6.

## 4. STUDY DATA ITERATIONS

### ADDITIONAL WORK UNDERTAKEN SINCE RAR ISSUE

4.1 The collection of baseline data is ongoing, and the discussion below considers the data collected since early May 2019. Additional data has become available for the Project since the RAR was initially compiled. Additionally, minor improvements to the assessment were noted, and are documented below.

4.2 Only baseline data collected until early 2019 is summarised and discussed in the RAR. Additional iterations to the assessment were made after that date, in full knowledge that baseline data collection was continuing, with relative confidence the additional data would have no impact on the outcome or recommendations included in the RAR. Since the RAR was issued in April 2020, there has been an opportunity to reflect on the additional baseline data that has been obtained, for comparison with data reported in the RAR.

This is discussed in paragraphs 4.6 – 4.9.

4.3 In September 2020 I noted an error in the surface water sample results in the RAR when compiling the additional sampling data. Identification numbering utilised during the SGS initial visit differed from the numbering system adopted by Kalbar in subsequent monitoring. This resulted in conflicting ID numbers being reported for identical locations. None of the analysis or data changed, only the corresponding locations reported. Results from the RAR and the corrected results are discussed further in 4.8.

4.4 Since the gamma survey was conducted in May 2017 (RAR, 5.1), SGS has completed a more detailed assessment of uncertainties for the detailed survey method adopted, including undertaking an uncertainty budget. This process has identified uncertainties approaching up to 40% at air kerma rates of 0.05 µGy/h and below.

The assessment of environmental radiation levels less than 0.1 µGy/h is complex, and the dose rates (including uncertainties) reported in Table 1 of the RAR should be considered indicative of average air kerma rates within the project area. A detailed grid survey of key areas including the process area and TSF will need to be conducted prior to project commencement (as recommended in RAR, Section 13), with consideration of the above-mentioned uncertainties. Detailed surveys of operational areas will provide sufficient baseline data for comparison with post-remediation survey data and criteria.

4.5 None of the data and information referred to above have altered the key findings as outlined in the RAR. This includes:

- Personal doses to Fingerboard employees, considering all exposure pathways, is expected to be less than the occupational dose limit, and the majority less than the dose limit applicable to members of the public, provided adequate controls are in place.
- An assessment of the impact to non-human species living in natural habitats concluded that the radiological impact on biota, including EPBC listed threatened species, is insignificant.
- The evaluation of potential exposure pathways for the public living near the Project area concluded that there should be no measurable radiological impact on members of the public from the Project either during operations or in the long term.

- Kalbar will need to comply with the Victorian *Radiation Act 2005*. The heavy mineral concentrate (HMC) is classified as 'radioactive material' under the *Act,* as the activity concentration is proposed to be greater than 1 Bq/g. The ore, overburden, and tailings is likely to have an activity concentration less than 1 Bq/g, and would not be considered as 'radioactive material' under the *Act.*
- A Management Licence will be required for all phases of commissioning, operation and rehabilitation of the Fingerboard Project. The Regulator, the Department of Health and Human Services, will impose strict conditions to protect workers, members of the public and the environment.
- The conclusions set out in the RAR are conditional on good radiation health practices being implemented, including enforcement of suitable controls, and that a Radiation Management plan, Radioactive Waste Management Plan and Radiation Environment Plan as approved by the regulatory authority, is complied with.

**Additional sample results available since preparation of the RAR**

4.6 As per 4.1-4.2, baseline data collection has continued following the completion of the RAR for the EES.

4.7 Baseline **passive radon** dosimeters results are available for January 2019 to August 2020 to complement the data collected and reported in the RAR from May 2017 to January 2020. Measurable concentrations of Ra-226 and Ra-228 for the entire assessment period are 15-48 Bq/m$^3$ and 20-119 Bq/m$^3$ respectively. All results are shown in Appendix C.

The additional data provides an opportunity to represent the results graphically over the entire issue period (Appendix C). Results indicate the variability of radon concentrations in the natural environment**.** For comparison purposes, the average radon level encountered within Australian homes is 10 Bq/m$^3$. As an additional comparison, currently the action level for radon concentrations in existing workplaces is 1000 Bq/m$^3$ as outlined in the ARPANSA *Guide for Radiation Protection in Existing Exposure Situations* (Refer RAR, Section 5.8).

Recommendations for future radon monitoring is discussed in paragraph 8.7.

4.8 Additional **surface water** samples were collected in December 2019. As per 4.3, I identified an error in the referenced locations, and for this reason results have been re-explained. All results are shown in Appendix E.

All results demonstrate a considerable variation in gross alpha and beta radioactivity, as identified in the RAR. Alpha and beta concentrations in the 'Property Dams' (SW-4 and SW-6), 'Mitchell River' (MR-1 and MR-3) were less than 0.07 Bq/L. Greater alpha concentrations were identified at 'Perry Gully Wombat Hole' (PG-1, alpha = 0.71 Bq/L), 'Creek Permit Road' (SW-2, alpha = 0.19 Bq/L) and Creek No. 34 Track (SW-1, alpha = 0.4 Bq/L and 2.4 Bq/L). The majority of samples demonstrated variable alpha and beta radioactivity, but all were less than the 0.5 Bq/L threshold stipulated in the ADWG. An unusually high alpha concentration of 2.39 Bq/L was identified for sample SW-1 in Dec 2019. Future sampling will confirm whether this result is an anomaly, or characteristic of the surface water sampled.

The highest measurable concentrations of the key radioisotopes in terms of radiological health, Ra-226 and Ra-228 were 0.02 – 0.07 Bq/L and 0.05 – 0.12 Bq/L respectively. Variation was identified between results from the same location.

4.9 Additional baseline samples from a limited number of **groundwater wells** (10) were analysed in December 2019 to complement samples analysed in May 2017 and September 2018. In many instances, identical wells were sampled. All results are shown in Appendix D.

In the Dec 2019 results, alpha/beta concentrations exceed the 0.5 Bq/L ADWG screening value of 0.5 Bq/L. Whilst exceedance is of little importance in this instance as the water is not considered a potable water source, the levels for the repeat wells sampled are considerably higher than previous results. Some increase in alpha/beta levels can be attributed to a notable increase in Ra-226/228 and Pb-210 levels, in other instances the reason for higher level is unknown. There is expected to be seasonal and temporal variations in radioactivity levels, but without more data, I can't draw any definitive conclusion on existing conditions. I have recommended more frequent well sampling and radioanalysis will be required to fully characterise existing radioactivity levels in groundwater before the project can establish a robust baseline data set (refer paragraph 8.3).

## 5. RESPONSE TO IAC QUESTIONS

5.1 I supported Kalbar in preparing responses to a number of questions from the IAC dated 11 December 2020, namely question 46 (refer Appendix F, Submission 514) and questions 64-65 (refer to Section 6.5.3).

## 6. PEER REVIEW

6.1 Mr Kenneth Henry Joyner, as Peer Reviewer, provided expert advice to the Inquiry and Advisory committee on the RAR.

6.2 In this section, the Peer Reviewers comments have been summarised, followed by my response.

6.3 Generally, the Reviewer was in agreement with the content of the RAR. Of note, in relation to impacts to members of the public, it was commented that:

- *methodologies and numerical values used for estimates/calculations of the exposures to the public are appropriate* (Clause 34)
- *With regard the exposure to airborne dust inhalation during operations – using conservative assumptions the maximum annual effective dose to a Critical Group member of the public, as a result of dust inhalation is estimated as 29 µSv which is a factor of approximately 35 below the limit of 1 mSv* (Clause 36)
- *in relation to exposure to radon/thoron gas I agree that the dose to a member of the public from this pathway is negligible* (Clause 38).
- *In relation to exposure via ingestion (crops) .. the prospective annual doses shown in Tables 17 and 18 of the Report represent conservative upper bounds* (Clause 39)

- *in relation to exposure via consumption of drinking water I am in agreement with the conclusion that the consumption of drinking water would be an inconsequential exposure pathway relative to other pathways assessed* (Clause 42).

6.4 Additional comments were made by the peer reviewer that I am in agreement with, and don't require a response:

- For transport purposes, process controls should be in place to ensure HMC total activity concentrations remain below 10 Bq/g to ensure exemption from the need to comply with shipping, documentation and placarding requirements. These process controls should be referenced in the Radiation Management Plan (Clause 18).

- Comment is made on the importance of ALARA taking into account 'economic, social and environmental factors'. ALARA is often interpreted as low as technically achievable which is not correct (Clause 20).

- Several comments suggested recommended inclusions in the Radiation Management Plan (RMP) relating to occupational exposures (Clauses 25 -30).

- Several comments suggested recommended inclusions in the Radioactive Waste Management Plan (RWMP) relating to handling of tailings including consideration of flooding (Clause 11) and measurement of maximum activity concentrations of the sand tailings (Clause 12).

6.5 Several additional comments were made by the Peer Reviewer which are set out below, together with my responses:

6.5.1 Management of tailings

*Clause 10:*
*The management of the tailings requires further consideration. It is not clear if the tailings will be stored in a dam or dams whilst awaiting the backfilling into the pit? There are repeated references to 'process water dams for reuse as mine process water' in Table 22 "Event consequences and likelihood - October 2018" – will the process water dams be used to store the tailings?*

DB Response: Tailings will be stored in the TSF before being returned to the mine void. The process water dams will not be used to store tailings. Water management for the project is discussed in *EES, Attachment D – EPA Works Approval Application*.

6.5.2 Updated codes

*Clause 13:*
*The Regulatory Framework discussion presented in the Report provides an overview of the relevant State and Commonwealth Acts, Radiation Regulations and Codes of Practice/Guidelines. However, I understand that the Victorian Government is in the process of*

*varying the licences for the transport of radioactive materials and applying the 2019 version of the Code of Practice for the Safe Transport of Radioactive Material (RPS C-2 2019) and not the 2014 version which is referenced in the Report. The Report also makes reference to the 2016 version of the Code for Radiation Protection in Planned Exposure Situations RPS C-1 which has been updated to the 2020 version - RPS C-1(Rev.1). Both RPS C-1 (2016) and RPS C-1 Rev.1 (2020) set out the requirements in Australia for the protection of occupationally exposed persons, the public and the environment in planned exposure situations but the 2020 version should be referenced.*

DB Response: Noted. The versions of RPS C-2 (2014) and RPS C-1 (2016) referenced in the RAR were current at the time of drafting. Kalbar will need to comply with the versions legislated in Victoria, as stipulated in the issued Management Licence. Applicable Codes will be referenced in future documents including the RMP and RWMP, still to be drafted. The updated Codes of Practice do not impact on the assessments and conclusions of the RAR.

6.5.3 Ingestion by livestock

*Clause 17:*
*With respect to non-human biota living in natural habitats the Report states that under the Victorian Radiation Act 2005 Kalbar will be required to commence preliminary assessments of potential radiation doses and the impact on the environment using the ARPANSA guidance document Guide for Radiation Protection of Environments RPS G-1 2015. Neither the EPBC Act nor the RPS G-1 cover domestic farm animals; in fact, RPS G-1 defines wildlife as 'Any wild animal or plant living within its natural environment. This excludes stock, farmed, feral or domesticated species.' In my view it is important to include stock, farmed and domestic species in the risk assessment as the Critical Group (Section 9.2.6 of the Report) has been identified as residents in the farming district directly north of the project and south of the Mitchell River. Exposure via ingestion of vegetables or soils has been considered as an exposure pathway for humans (Section 9.2.3 of the Report) but clearly grazing animals will consume significant amounts of grasses daily and it is my view that the impact on downstream dairy and beef/lamb production should be considered in the risk assessment.*

DB Response:

Human consumption of grazing farm animals and related produce, was seen as an inconsequential exposure pathway relative to other pathways assessed. This decision was based on the low radioactive content of the dust, and the estimated doses to a member of the public as result of crop consumption directly.

Internationally recognised literature (IAEA 2010, Part 6) discusses the transfer of radionuclides to livestock in the natural environment. It is recognised the ingestion of contaminated feed is the major pathway for livestock. It is the ingestion of contaminated feed, and the absorption and retention of that feed, that will determine radionuclide content in animals. Absorption values differ only slightly for ruminants (cattle) in comparison with monogastric animals (pigs, hens, and humans). Transfer to tissue and milk products will be largely dependent on an animal's diet including feeding strategies, agricultural practices, and local seasonal conditions.

Whilst this exposure pathway is considered to present a negligible risk, it can be modelled using commercially available software. Data on local farming practices can be used as inputs where it is applicable.

I recommend that an assessment of this exposure pathway be undertaken for incorporation into the Radiation Environment Plan (refer to section 8.9 below). The REP requires approval from the Victorian DHHS prior to issue of a Management Licence.

6.5.4 Radionuclides in dust

*Clause 37:*
*The analysis of radionuclides in environmental dust should be included in the environmental monitoring program.*

DB Response: Agreed, it will be important to fully characterise TSP environmental airborne dust once operations commence, including identification of the radionuclide content. The preferred method, gamma ray spectrometry, may be difficult based on minimum detection levels, and the small mass of dust loadings. However, total U and Th content will be possible allowing radionuclide activities to be inferred assuming equilibrium of decay chain progeny. (Refer Statement, Section 7).

## 7. RESPONSE TO SUBMISSIONS

7.1 I have reviewed the submissions that have raised issues in relation to the radiological impacts of the Fingerboard Project. A summary of submissions and my responses are provided in Appendices F and G**.**

7.2 Radiation related comments pertaining to submissions from Regulators, are provided in Appendix F.

7.3 Radiation related comments pertaining to submissions from parties other than regulators, including members of the public, are provided in Appendix G.

Comments have been sorted and responded to based on specific areas of concern. These areas as follows:

- General comments
- Regulatory framework concerns
- Baseline assessment
- DAF Plant
- Occupational radiation protection
- Transport
- Radon gas
- Airborne radioactive dust

- Dust impact on surface water quality
- Dust impact on consumption of locally grown vegetables
- Tailings storage facility

7.4 I have addressed Submissions relating to the following two matters:

- Comments related to the content of the RAR; and
- General comments or concerns on health related to radioactive material or radiation exposure, even if beyond the scope of the RAR.

7.5 Responses have been limited to those concerns related directly to the Fingerboard Project. Other than in a general capacity, I haven't commented on other projects, current or historical, including those within Australia.

7.6 In preparing this statement, I have endeavoured to respond to all relevant submissions. However, where a submitter has raised multiple issues, some if common to other submissions, may not be specifically listed.

## 8. PROPOSED MANAGEMENT PLAN

8.1 Kalbar will be required to submit a Radiation Management Plan (RAR, Section 10) and a Radioactive Waste Management Plan (RAR, Section 11). Both documents will stipulate ongoing monitoring requirements and controls that will be required for the Project. A Radiation Environment Plan (RAR, Section 12) will also be required.

A Future Work Plan (RAR, Section 13) outlines further work to be conducted by Kalbar prior to commissioning. These requirements still apply, however it is worthwhile elaborating further based on the recent monitoring data described earlier this this statement.

8.2 Some additional recommendations have been made in response to some of the suggestions put forward in the submissions.

8.3 **Groundwater** – It is important that Kalbar and regulators have a solid understanding of the pre-mining radionuclide content of the local groundwater system - specifically Ra-226 and Ra-228 concentrations. Currently sampling is received by SGS annually for a few wells which has occurred end of 2017, 2018 and 2019. It is acknowledged samples have been collected by other parties and reported by Coffey, but laboratory assessment has been limited to alpha/beta screening. Radium is of particular interest due to its greater mobility in water compared with U and Th, and is more radio-toxic when ingested, delivering a greater dose than other U and Th chain radionuclides. (For this reason, it is this radionuclide singled out in the ADWG for supplementary assessment as required).

To ascertain existing conditions, I recommend a minimum of 12 months data be collected, to allow for possible seasonal variations. A specialist with an understanding of the local groundwater flows and activities should be consulted to establish a suitable monitoring program.

8.4 **Surface water** - there is a reasonable subset of samples analysed from dams and creeks to date. However, it is noted only two samples have been collected (by SGS in May 2017) from the Mitchell River. I acknowledge that other Mitchell River samples were collected and reported

by Coffey, however none of the samples were analysed for Ra-226 and Ra-228 content. Being the main local water source feeding into the Woodglen WTP, there needs to be substantial baseline data in this area to gain a full understanding of existing conditions. I recommend regular monitoring and analysis for a minimum 12 months period to capture any seasonal variations.

Additional water samples collected from rainwater tanks should be similarly collected and analysed for Ra-226 and Ra-228. Consideration should also be given to collection and analysis of any accumulated sediments associated with the tanks.

8.5 **Long-lived radionuclides**. A subset of samples including surface waters and ground water should be analysed for the full suite of naturally occurring long-lived radionuclides, including U-238 and U-235. Whilst Ra-226 and Ra-228 are the principle radionuclides of interest from a mobility perspective, it is important to have an indication of radioactive concentration of baseline head of chain radionuclides likely to be present.

8.6 **Air sampling** - Particulate monitoring for gross alpha/beta analysis needs to occur for at least 12 months. This will need to be HiVol with a TSP head sampling a minimum 5000 $m^3$ air volume. This sampling volume will provide sufficient sensitivity for the gross radioactivity analysis in the laboratory. (Analysis to date has been limited to PM10 filters collected during the air quality study). HiVol sampler positions should reflect where monitoring will occur for the duration of the project, as part of the radiation monitoring program. Careful consideration of the monitoring location will be required based on the sensitive receptors for the Project.

Characterisation of the radionuclide content of the collected dust will be conducted by gamma ray spectrometry where sufficient dust loadings are collected.

8.7 In-pit **Radon** monitoring during test pit operations should be conducted. Whilst radon doses to members of the public is likely to be negligible, upcoming test pit operations will provide an opportunity to identify levels once the ore body is exposed. Monitoring should include passive detectors, but also real-time monitoring can be conducted. Workplace monitoring for radon will be an integral part of the radiation monitoring program during operations.

8.8 **Crops** - Analysis of radionuclides present in locally grown crops as outlined in the Future Work Plan will be required. Based on the genuine concerns expressed by local landowners, it will be important for Kalbar to have a good understanding of baseline concentrations present in a range of crops from local producers. Irrespective of any dust deposition, the radionuclide concentrations can vary substantially based on vegetable type, fertiliser and cultivation methods.

8.9 **Grazing cattle -** The potential impact on human consumption of grazing farm animals and related produce will need to be considered, in light of any resuspended dusts from the Project that may settle on feedstock. Whilst the radioactive content of airborne dusts is considered low, it is acknowledged volumes of consumption, and radionuclide retention factors in livestock may differ to humans.

As discussed in section 6.5.3 above, I recommend that this assessment pathway be modelled using commercially available software that is available for inclusion in the Radiation Environmental Plan (REP) to be developed. The REP requires drafting and approval from the Victorian DHHS prior to issue of a Management Licence.

## 9. DECLARATION

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 Inquiry and Advisory Committee.

Signed: … 

Dated: 29th January 2021

## APPENDIX A – DARREN BILLINGSLEY CURRICULUM VITAE

| Qualifications | | |
|---|---|---|
| 1999 | Deakin University | Graduate Diploma Occupation Hygiene |
| 1989 | University of South Australia | Bachelor Applied Science (Applied Physics) |
| **Memberships** | | |
| Current | Australasian Radiation Protection Society | Full Member |
| Current | Australasian Radiation Protection Accreditation Board | Certification in Ionising Radiation Safety within Australasia and the Pacific Region |
| **Training** | | |
| 21/10/2003 | Current | Certificate IV in Assessment and Workplace Training |
| 15/2/2019 | Current | OPITO Bosiet with EBS (267351) |
| 18/10/2008 | Current | Confined Space Training (PMAPER200C) |
| 14/1/2016 | Current | Certificate IV in Frontline Management |
| **Employment History** | | |
| 2013 - present | SGS Australia Pty Ltd | Senior Health Physicist, SGS Australian Radiation Services |
| 2000-2013 | Australian Radiation Services | Senior Health Physicist, SGS Australian Radiation Services |
| 1996-2000 | CH2M Hill, Sydney | Deputy Site Manager, Maralinga Rehabilitation site, South Australia |
| 1990-1994 | Western Mining | Mine Radiation Safety Office, Olympic Dam Operations |

| Statement of Experience |
|---|
| Darren has been employed at SGS Australian Radiation Services since 2000 with extensive experience with environmental radiation and industrial work sites. This includes NORM monitoring and the provision of advice to the oil and gas sector, mining, mineral sands and uranium mining industry. Including the development of radiation assessments for EIS and development RMPs for new sites, and the rehabilitation of contaminated sites. Extensive experience on industrial sites with fixed and portable gauges, cabinet x-ray units including training, source disposal, and transport. Experience with management of unsealed sources in laboratory environment. |

Darren's professional expertise can be summarised into several key areas of radiation protection in industry. Within the environmental, uranium mining and mineral sands industry experience includes;

- Radiation Safety Officer for the Olympic Dam Operations operating underground copper/uranium mine. Includes implementation of a radiation monitoring programme incorporating external and internal exposure assessment, employee dose calculations using standards techniques, and presentation to regulators.
- Undertaking environmental radiological surveys using internationally recognized environmental monitoring techniques. Conducted for baseline and remediation surveys for new and historical mining operations, ex fertiliser processing sites, and contaminated residential properties.
- Development of pre-feasibility studies and radiation assessment reports for EIS documents associated with new mineral sands operations in Victoria, including assessment of potential doses to workers and members of the public.
- Preparation and implementation of Radiation Management Plans and Radioactive Waste Management Plans for mining operations.
- Preparation of Transport Management Plans for mineral sands operations
- Project management and health physics coverage during cleaning of process scrap from an old scrubber system highly contaminated with NORM scale. Facilitated the disposal of bulk NORM waste to an approved overseas recipient facility which was the first successful disposal out of Western Australia ($1.8M Project).
- Presentation of 4-day courses to mineral sands operations on Radiation Awareness and NORM in the Mineral Sands Industry.

Professional experience in other industries includes:

- Provide health physics support and NORM management advice to onshore and offshore oil and gas operations throughout Australasia, including implementation of handling procedures, provision of radiation awareness training to a workforce, and in-field radiation monitoring resulting in risk-based decision making. A variety of operations supported since 2000 including general operations for upstream and downstream facilities, maintenance shutdowns (fixed rig and FPSO), well recovering work, subsea equipment assessment and recovery, PIG recovery support, and coal seam gas operations.
- A thorough knowledge of and practical experience in applying the appropriate jurisdictional radiation Act and Regulations, codes of practice or associated standards, pertaining to the use of radioactive material or radiation apparatus.
- Training by the Los Alamos National Laboratory, US Department of Energy, in the loading of and quality assurance testing of field sealable special form capsules. The US Department of Transport has registered Australian Radiation Services as an authorised user and assembler of these capsules.
- Packaging of radioactive material in accordance with the *Code of Practice for the Safe Transport of Radioactive Material* and the International Air Transport Association *Dangerous Goods Regulations.*
- Conducting compliance assessments of sealed source devices and irradiating apparatus to regulatory standards, including fixed and portable gauges, cabinet screening and X-ray analysis equipment, radiography devices and exposure facilities, and borehole logging equipment.
- Undertaking field characterisations of documented, undocumented and leaking radioactive material
- Handling and over-encapsulation of source capsules leaching radioactive material
- Assessing potential hazards prior to and during the handling of bare source capsules
- Performing "seek and find" operations on misplaced radiation sources including preparation of risk assessments to potential waste streams the source(s) may have entered.
- Undertaking surveys and audits of laboratories in which unsealed sources have been used.
- Conducting a variety of course for SGS on Radiation Awareness and Fixed Gauges, Borehole logging and X-ray apparatus to clients

Some of the major mining, environmental and remediation projects conducted by SGS Australia, with direct project management or involvement by Darren Billingsley;

- **Wim Resource – Avonbank Project** – Baseline radiological survey and preparation of Radiation Assessment report for the EES. Preparation of RMP and RWMP for Pilot Plant study and current RSO for operations (2018 - current).
- **Coffey Resources / Kalbar – Fingerboard Project** – Baseline radiological survey for the EES (2016 - current).
- **Australian Zircon, WIM150 Mineral Sands Project** – Baseline radiological survey and preparation of Radiation Assessment report for the EES (2012 - 2016).

- **Coffey Resources: Iluka Murray Basin Stage 2 Mineral Sands Project** – Baseline radiological survey and Radiation Assessment report (2006) and development of Radiation Management Plan and Radioactive Waste Management Plan (2007).
- **Coffey Resource Resources/Enesar: Donald Mineral Sands Mine** – Baseline radiological survey, preparation of assessment report for EES (2007), and development of Radiation Management Plan and Radioactive Waste Management Plan (2011)
- **Iluka Resources Murray Basin** - RSO training, annual audit of industrial gauges containing radiation sources (2011-current).
- **Sheffield Resources, Thunderbird Project** – Characterisation of test samples for pre-feasibility study of WA heavy mineral project, review regulatory requirements, transport assessment, and evaluation of anticipated radiological hazards (2014 – current).
- **Naracoopa Mineral Sands, King Island** – Baseline radiological survey of beach mining operation. Preparation and submission to Tasmanian regulator for approval. Site visits for implementation of approved radiation monitoring program. Preparation of annual radiation reports (2009 – 2014).
- **Incitec Pivot Ltd.** – Completed a radiological survey of its 25 ha Newcastle site, previously used for the processing of phosphates for the fertiliser industry (2005).
- **Pilbara Iron: Cape Lambert Operations WA** – Project management and health physics coverage during cleaning of process scrap from an old scrubber system highly contaminated with NORM scale. The steel scrap was recycled. Bulk NORM was disposed of to an approved overseas recipient facility which was the first successful disposal out of Western Australia ($1.8m budget) (2011-2016).
- **Wesfarmers, Bayswater** – Site survey and radiological impact assessment of the Western Australia site which had been historically used for processing of superphosphogypsum (2014).
- **No. 5 Nelson Parade, Hunters Hill** – Conducted a radiological assessment of the property at 5 Nelson Parade, Hunters Hill for the property owner. Included a review of previous assessments undertaken and assessment of potential doses to occupants, including those as a result of the ingestion of food grown on the site (April 2012).
- **No. 11 Nelson Parade, Hunters Hill** – Conducted the radiological assessment of the property at 11 Nelson Parade, Hunters Hill with ERM, on behalf of the property owner. Site remediation is to be undertaken as a result of the assessment. SGS are the first organisation to conduct integrated 'tissue equivalent' radiation monitoring on the site, which was accepted by the NSW parliamentary enquiry which resulted from the survey (2008).
- **Sita Australia** – Conducting the baseline assessment at the Kemp Creek landfill facility for receipt of NORM waste from the Hunters Hill site (2009).

## APPENDIX B – LETTER OF ENGAGEMENT

WHITE & CASE

15 September 2020

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

GPO Box 2758
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Australia

T +61 3 8486 8000

ABN 17 847 592 731

whitecase.com

Darren Billingsley
SGS Australia
104 Francis Road
Wingfield, South Australia 5013

By email: darren.billingsley@sgs.com

**Confidential and subject to legal professional privilege**

Dear Mr Billingsley

**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;

(ii) briefly describe and summarise the Radiation Assessment 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.

WHITE & CASE

15 September 2020

## 8. Costs and invoicing

SGS Australia 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

**Tim Power**
Partner

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E timpower@whitecase.com

Kirsty Campbell

**Kirsty Campbell**
Senior Associate

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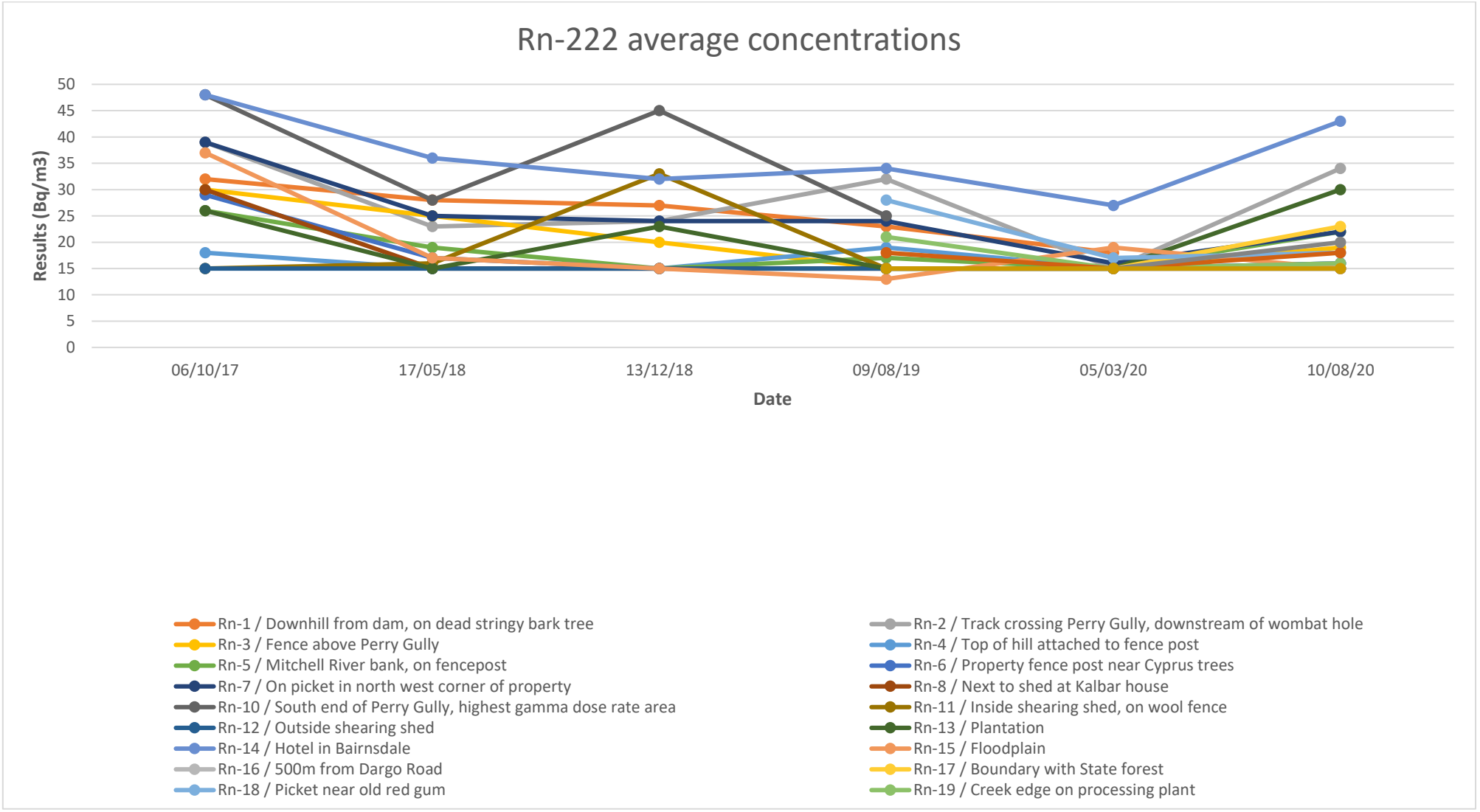
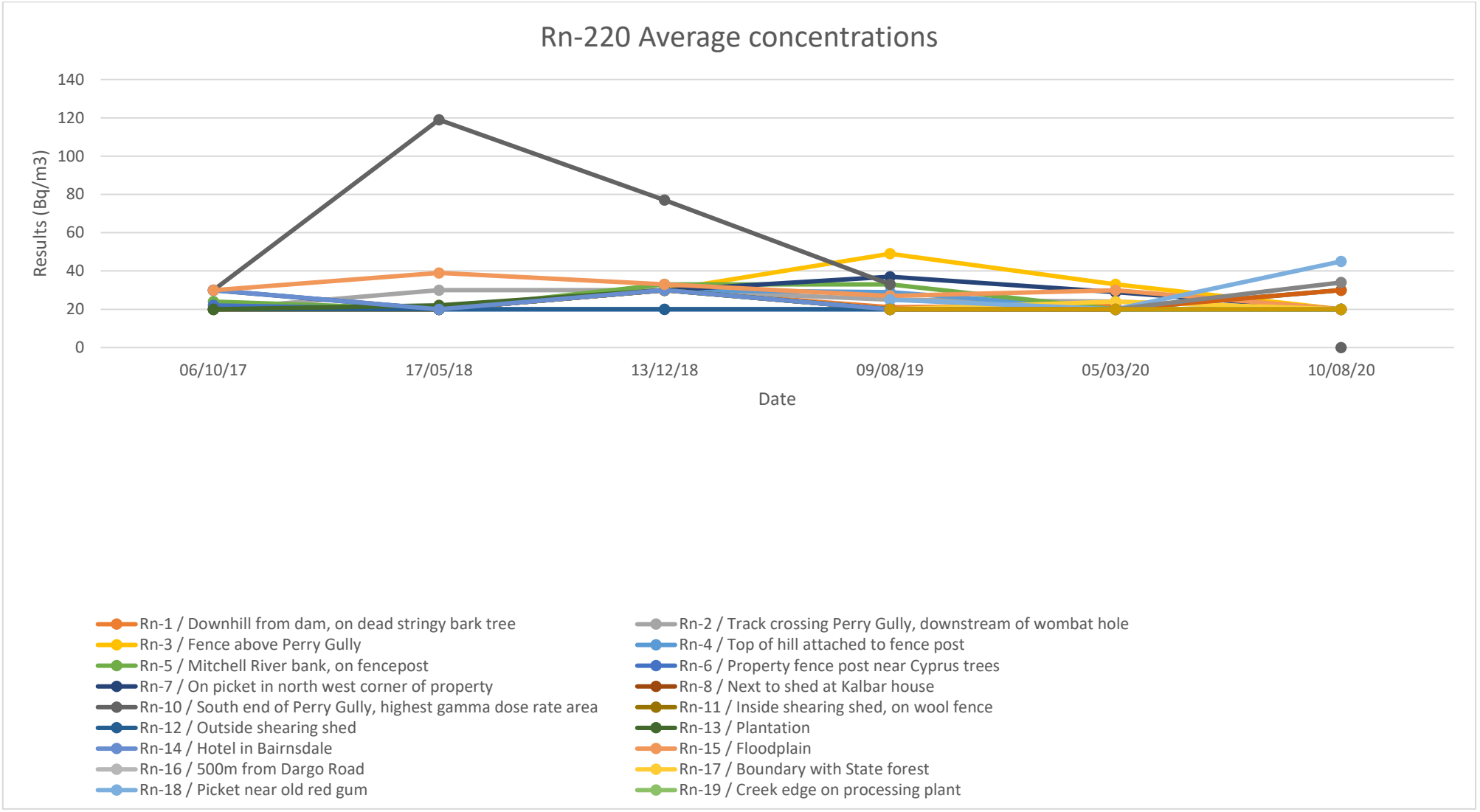
Enc: Planning Panel Victoria's *Guide to Expert Evidence* - April 2019

## APPENDIX C – BASELINE PASSIVE RADON MONITORING (2017-2020)

| Location ID | Issue 1 9/5/17-06/10/17 | | Issue 2 6/10/17-17/05/18 | | Issue 3 17/5/18-13/12/18 | | Issue 4 12/12/18-09/08/19 | | Issue 5 12/8/19-05/03/20 | | Issue 6 5/3/20-10/08/20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rn-222 ($Bq/m^3$) | Rn-220 ($Bq/m^3$) | Rn-222 ($Bq/m^3$) | Rn-220 ($Bq/m^3$) | Rn-222 ($Bq/m^3$) | Rn-220 ($Bq/m^3$) | Rn-222 ($Bq/m^3$) | Rn-220 ($Bq/m^3$) | Rn-222 ($Bq/m^3$) | Rn-220 ($Bq/m^3$) | Rn-222 ($Bq/m^3$) | Rn-220 ($Bq/m^3$) |
| Rn-1 | 32 ± 4 | <20 | 28 ± 4 | < 20 | 27 10 | < 30 | 23 ± 4 | 21 ± 16 | 18 ± 6 | 22 ± 14 | | |
| Rn-2 | 39 ± 6 | < 20 | 23 ± 6 | < 30 | 24 ± 8 | < 30 | 32 ± 6 | 25 ± 18 | < 15 | 24 ± 14 | 34 ± 8 | < 20 |
| Rn-3 | 30 ± 6 | < 20 | 25 ± 4 | < 20 | 20 ± 6 | < 30 | < 15 | 49 ± 20 | < 15 | 33 ± 14 | 19 ± 6 | < 20 |
| Rn-4 | 18 ± 4 | < 20 | < 15 | < 20 | < 15 | < 30 | 19 ± 4 | 29 ± 16 | < 15 | < 20 | 16 ± 6 | < 20 |
| Rn-5 | 26 ± 4 | 24 ± 16 | 19 ± 4 | < 20 | 15 ± 8 | 33 ± 20 | 17 ± 4 | 33 ± 16 | 15 ± 6 | 20 ± 14 | 22 ± 8 | < 20 |
| Rn-6 | 29 ± 6 | 22 ± 18 | 17 ± 4 | < 20 | < 15 | < 20 | 15 ± 4 | < 20 | < 15 | < 20 | 16 ± 6 | < 20 |
| Rn-7 | 39 ± 6 | < 30 | 25 ± 4 | < 20 | 24 ± 8 | < 30 | 24 ± 8 | 37 ± 22 | 16 ± 6 | 29 ± 14 | 22 ± 6 | < 20 |
| Rn-8 | 30 ± 6 | < 20 | <15 | <20 | < 15 | < 30 | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 |
| Rn-10 | 48 ± 6 | < 30 | 28 ± 8 | 119 ± 30 | 45 ± 8 | 77 ± 30 | 25 ± 4 | 33 ± 18 | N2 | N2 | | |
| Rn-11 | < 15 | < 20 | 16 ± 4 | < 20 | 33 ± 8 | < 30 | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 |
| Rn-12 | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 |
| Rn-13 | 26 ± 4 | < 20 | 15 ± 4 | 22 ± 14 | 23 ± 6 | < 30 | < 15 | < 20 | < 15 | < 20 | 30 ± 12 | < 30 |
| Rn-14 | 48 ± 6 | < 30 | 36 ± 6 | < 20 | 32 ± 8 | < 30 | 34 ± 6 | < 20 | 27 ± 6 | < 20 | 43 ± 8 | < 20 |
| Rn-15 | 37 ± 6 | < 30 | 17 ± 6 | 39 ± 20 | < 15 | 33 ± 20 | 13 + 4 | 27 + 4 | 19 ± 8 | < 30 | 15 ± 6 | < 20 |
| Rn-16 | | | | | | | < 15 | < 20 | < 15 | < 20 | < 15 | < 20 |
| Rn-17 | | | | | | | < 15 | < 20 | < 15 | 24 ± 14 | 23 ± 8 | < 20 |
| Rn-18 | | | | | | | 28 ± 6 | 25 ± 18 | 17 ± 6 | < 20 | 18 ± 6 | 45 ± 14 |
| Rn-19 | | | | | | | 21 ± 4 | < 20 | < 15 | < 20 | 16 ± 6 | < 20 |
| Rn-20 | | | | | | | < 15 | < 20 | N3 | N3 | N1 | N1 |
| Rn-21 | | | | | | | 18 ± 4 | < 20 | < 15 | < 20 | 18 ± 12 | < 30 |
| Rn-22 | | | | | | | < 15 | < 20 | < 15 | < 20 | 20 ± 12 | 34 ± 24 |


Rn-222 average concentrations
Results (Bq/m3)
50
45
40
35
30
25
20
15
10
5
0
06/10/17
17/05/18
13/12/18
09/08/19
05/03/20
10/08/20
Date
Rn-1 / Downhill from dam, on dead stringy bark tree
Rn-2 / Track crossing Perry Gully, downstream of wombat hole
Rn-3 / Fence above Perry Gully
Rn-4 / Top of hill attached to fence post
Rn-5 / Mitchell River bank, on fencepost
Rn-6 / Property fence post near Cyprus trees
Rn-7 / On picket in north west corner of property
Rn-8 / Next to shed at Kalbar house
Rn-10 / South end of Perry Gully, highest gamma dose rate area
Rn-11 / Inside shearing shed, on wool fence
Rn-12 / Outside shearing shed
Rn-13 / Plantation
Rn-14 / Hotel in Bairnsdale
Rn-15 / Floodplain
Rn-16 / 500m from Dargo Road
Rn-17 / Boundary with State forest
Rn-18 / Picket near old red gum
Rn-19 / Creek edge on processing plant


Rn-220 Average concentrations
140
120
100
80
60
40
20
0
Results (Bq/m3)
06/10/17
17/05/18
13/12/18
09/08/19
05/03/20
10/08/20
Date
Rn-1 / Downhill from dam, on dead stringy bark tree
Rn-2 / Track crossing Perry Gully, downstream of wombat hole
Rn-3 / Fence above Perry Gully
Rn-4 / Top of hill attached to fence post
Rn-5 / Mitchell River bank, on fencepost
Rn-6 / Property fence post near Cyprus trees
Rn-7 / On picket in north west corner of property
Rn-8 / Next to shed at Kalbar house
Rn-10 / South end of Perry Gully, highest gamma dose rate area
Rn-11 / Inside shearing shed, on wool fence
Rn-12 / Outside shearing shed
Rn-13 / Plantation
Rn-14 / Hotel in Bairnsdale
Rn-15 / Floodplain
Rn-16 / 500m from Dargo Road
Rn-17 / Boundary with State forest
Rn-18 / Picket near old red gum
Rn-19 / Creek edge on processing plant

## APPENDIX D – GROUND WATER SAMPLING (2017-2019)

| Sample Location | Gross Radioactivity Concentration (Bq·L$^{-1}$)[a,b] | | Radionuclide concentration (Bq·L$^{-1}$)[a,b] | | | | |
|---|---|---|---|---|---|---|---|
| | Gross alpha | Gross beta[c] | U-238 (as Th-234) | Ra-226 | Pb-210 | Ra-228 | Th-228 |
| MW01 (May 17) | 0.178 ±0.041 | 0.189 ±0.048 | - | - | - | - | - |
| MW01 (Sep 18) | 0.096 ±0.030 | 0.052 ±0.035 | < 0.18 | 0.030 ± 0.012 | 0.077 ± 0.054 | <0.110 | <0.030 |
| MW01 (Dec 19) | 0.395 ±0.086 | 0.122 ±0.041 | < 0.18 | 0.024 ± 0.018 | 0.143 ± 0.052 | <0.076 | <0.027 |
| MW02 (May 17) | 0.085 ±0.031 | 0.061 ±0.040 | - | - | - | - | - |
| MW02 (Sep 18) | 0.069 ±0.024 | 0.080 ±0.036 | < 0.20 | 0.030 ± 0.011 | <0.190 | <0.110 | <0.033 |
| MW02 (Dec 19) | 0.848 ±0.163 | 0.232 ±0.053 | 0.082 ± 0.046 | 0.023 ± 0.013 | 0.138 ± 0.063 | <0.120 | <0.033 |
| MW03 (May 17) | 0.425 ±0.068 | 0.204 ±0.046 | < 0.11 | 0.077 ± 0.015 | 0.050 ± 0.040 | 0.083 ± 0.029 | 0.027 ± 0.010 |
| MW03 (Sep 18) | 0.117 ± 0.030 | 0.121 ±0.039 | < 0.16 | 0.062 ± 0.013 | <0.150 | 0.055 ± 0.022 | <0.025 |
| MW03 (Dec 19) | 0.164 ± 0.047 | 0.091 ± 0.038 | < 0.19 | 0.037 ± 0.011 | <0.170 | 0.056 ± 0.025 | <0.025 |
| MW04 (May 17) | 0.270 ±0.044 | 0.314 ±0.050 | < 0.34 | 0.149 ± 0.026 | < 0.320 | 0.149 ± 0.045 | < 0.063 |
| MW04 (Sep 18) | 0.238 ±0.035 | 0.313 ±0.041 | < 0.14 | 0.106 ± 0.017 | 0.076 ± 0.050 | 0.207 ± 0.037 | < 0.037 |
| MW04 (Dec 19) | 0.854 ±0.165 | 0.288 ±0.067 | 0.506 ± 0.090 | 0.068 ± 0.019 | 0.155 ± 0.065 | 0.074 ± 0.032 | < 0.025 |
| MW06 (May 17) | 0.272 ±0.050 | 0.347 ±0.051 | < 0.19 | 0.083 ± 0.016 | 0.075 ± 0.050 | 0.065 ± 0.026 | < 0.030 |
| MW06 (Dec 19) | 0.801 ±0.141 | 0.889 ±0.127 | < 0.525 + 0.079 | 0.196 ± 0.021 | 0.301 ± 0.064 | 0.268 ± 0.035 | 0.010 ± 0.010 |
| MW07 (May 17) | 0.159 ±0.039 | 0.065 ±0.026 | - | - | - | - | - |
| MW07 (Sep 18) | 0.231 ±0.028 | 0.302 ±0.037 | < 0.39 | 0.173 ± 0.036 | < 0.340 | 0.229 ± 0.074 | < 0.079 |
| MW07 (Dec 19) | 0.244 ±0.060 | 0.238 ±0.059 | <0.130 | 0.164 ± 0.022 | < 0.340 | 0.214 ± 0.035 | < 0.028 |
| MW08 (May 17) | 0.065 ±0.026 | 0.091 ±0.044 | - | - | - | - | - |
| MW08 (Sep 18) | 0.277 ±0.043 | 0.169 ±0.044 | < 0.11 | 0.051 ± 0.018 | 0.082 ± 0.070 | 0.066 ± 0.040 | < 0.036 |
| MW08 (Dec 19) | 0.699 ± 0.143 | 0.477 ±0.081 | 0.202 ± 0.059 | 0.102 ± 0.015 | 0.113 ± 0.046 | 0.142 ± 0.030 | < 0.031 |
| MW03 (Dec 19) | 0.164 ± 0.047 | 0.091 ± 0.038 | < 0.019 | 0.037 ± 0.011 | < 0.17 | 0.056 ± 0.025 | < 0.035 |

| Sample Location | Gross Radioactivity Concentration (Bq·L$^{-1}$)[a,b] | | Radionuclide concentration (Bq·L$^{-1}$)[a,b] | | | | |
|---|---|---|---|---|---|---|---|
| | Gross alpha | Gross beta[c] | U-238 (as Th-234) | Ra-226 | Pb-210 | Ra-228 | Th-228 |
| LA-01-DM (Dec 19) | 0.075 ± 0.033 | 0.062 ± 0.039 | < 0.016 | 0.052 ± 0.013 | < 0.14 | < 0.088 | < 0.022 |
| LA-02-DM (Dec 19) | 1.06 ± 0.20 | 0.449 ± 0.087 | 0.202 ± 0.057 | 0.049 ± 0.017 | 0.227 ± 0.057 | 0.089 | < 0.025 |
| LA-01-SM (Dec 19) | 0.150 ± 0.042 | 0.057 ± 0.038 | < 0.14 | < 0.046 | < 0.13 | < 0.14 | < 0.030 |
| MW09d (Dec 19) | 0.151 ± 0.043 | 0.113 ± 0.043 | < 0.18 | 0.062 ± 0.019 | 0.125 ± 0.066 | 0.087 ± 0.039 | < 0.043 |

## APPENDIX E – SURFACE WATER SAMPLING (2017-2019)

| Kalbar ID | | Location | Gross Radioactivity Concentration (Bq·L$^{-1}$)[a,b] | | Radionuclide concentration (Bq·L$^{-1}$)[a,b] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross alpha | Gross beta[c] | U-238 (as Th-234) | Ra-226 | Pb-210 | Ra-228 | Th-228 |
| PG-1 | May-17 | Perry Gully (wombat hole) | 0.173 ± 0.040 | 0.118 ± 0.046 | < 0.15 | 0.015 ± 0.010 | 0.052 ± 0.040 | < 0.075 | 0.024 ± 0.009 |
| SW-1 | Sep-18 | Creek - No.34 Track | 0.395 ± 0.061 | 0.139 ± 0.038 | < 0.16 | 0.041 ± 0.012 | 0.071 ± 0.049 | 0.055 ± 0.022 | < 0.022 |
| SW-1 | Dec-19 | Creek - No.34 Track | 2.39 ± 0.42 | 0.39 ± 0.103 | < 0.200 | 0.073 ± 0.019 | 0.205 ± 0.059 | 0.121 ± 0.026 | < 0.030 |
| SW-2 | Sep-18 | Creek - Permit Road | 0.190 ± 0.034 | 0.106 ± 0.036 | < 0.21 | 0.028 ± 0.012 | < 0.160 | < 0.120 | < 0.035 |
| SW-4 | May-17 | Property Dam | 0.031 ± 0.022 | < 0.066 | - | - | - | - | - |
| SW-4 | Sep-18 | Property Dam | 0.035 ± 0.019 | 0.055 ± 0.042 | < 0.12 | < 0.034 | < 0.130 | < 0.110 | < 0.021 |
| SW-4 | Dec-19 | Property Dam | 0.056 ± 0.026 | < 0.075 | < 0.150 | < 0.053 | < 0.150 | < 0.160 | < 0.036 |
| SW-6 | May-17 | Property Dam | 0.035 ± 0.021 | < 0.071 | - | - | - | - | - |
| SW-6 | Sep-18 | Property Dam | 0.041 ± 0.020 | 0.042 ± 0.041 | < 0.12 | < 0.042 | < 0.079 | < 0.140 | < 0.029 |
| SW-6 | Dec-19 | Property Dam | < 0.034 | 0.075 ± 0.043 | < 0.110 | < 0.030 | < 0.110 | < 0.130 | < 0.021 |
| MR-3 | May-17 | Mitchell River (downstream) | 0.055 ± 0.024 | < 0.071 | - | - | - | - | - |
| MR-1 | May-17 | Mitchell River (upstream) | 0.041 ± 0.022 | < 0.071 | - | - | - | - | - |
| Mortons | Dec-19 | Property Dam | 0.091 ± 0.030 | 0.034 ± 0.04 | <0.14 | 0.020 ± 0.011 | < 0.130 | < 0.066 | < 0.027 |

## APPENDIX F – DETAILED SUBMISSION RESPONSES - GOVERNMENT

### SUBMISSION 514

**Section 6.3.4 Horticultural Crops comment:-**

*The Human Health Risk Assessment section 9.1.4 concludes that:*
*(point 1), and*
*The increased doses [of radiation] are not considered to be significant based on a comparison of the estimated doses for the years following commencement of project operations with those calculated as baseline intakes (current exposures). In addition, when considering the variation in natural radioactivity levels encountered in soils worldwide, the impact is negligible of dust deposition on existing soil concentrations as a result of emissions predicted from project activities.*

*Based on the information provided in the Human Health Risk Assessment, EPA does not expect dust from the Project to adversely affect the integrity of crops grown or human health. However, EPA recommends, as a precautionary measure, that periodic monitoring (sampling and testing) of dust deposited on horticultural crops grown near the project site be carried out.*

DB Response: I am in agreement.

**Section 7.3 Radiation comment:-**

*In considering whether the works the subject of the WAA are a radiation source within the meaning of the radiation Act 2005, EPA will need to consider whether:*

- *radionuclides may be present within the mine contact waters being treated;*

DB Response:

Rainwater has radioactive content, so the issue is what radionuclides will be added to rainwater runoff due to contact with stockpiles and exposed surface soils. The run-off will have a soluble (water) and insoluble (particulate) radioactive component.

The source of radioactivity from mine contact would be dependant on the radioactive content of solids collected by the runoff, in this case predominantly overburden (0.025 Bq/g) (EES, Appendix A002, Table 7) and other topsoils. Activity concentrations in overburden and topsoils is comparable to that found naturally occurring in common garden soils (RAR, Section 5.2).

So, the insoluble fraction contribution would be directly dependant on the radioactivity of the solids collected by the runoff - in this instance low

In regard to the soluble radioactive fraction, the key elements from a radioactivity perspective (U, Th and Ra) have a low solubility in water, and thus the contribution from collected solids – with low radioactive content – will be negligible.

- *the effectiveness of the DAF plant to remove any potential radionuclides present in the suspended solids within the mine contact water;*

DB Response:
The DAF Plant will not 'remove radionuclides' per say. However, Kalbar have advised the filtrate is 90 - 95% effective in removing solid content (Hydroflux email, 27/11). Subsequently, 90 - 95% of the insoluble component will be collected in the filtrate. The soluble component will not be collected and would pass through the DAF Plant, though as explained above I believe the soluble radioactive content in mine contact water will be negligible.

- *radionuclides may be present within the solid wastes from the DAF plant and their subsequent disposal;*

DB Response:

Radionuclides will be present in the solid wastes. Kalbar advised they expect the filtrate to collect a maximum 125 tonnes of particulate material annually. To evaluate the implications of this scenario, one can hypothetically assume that all solids collected by the water run-off is ore particulate, and the radioactive concentration of these solids is 1 Bq/g. This is an ultra-conservative assumption, as in reality it is likely to be overburden (0.025 Bq/g) and non-radioactive surface materials collected from the site.

.

Kalbar has proposed the DAF solids be blended with 2.4 Mtonne of fine tailings, which has been characterised to have a total activity of 0.5 Bq/g (RAR, Table 12). Thus 2,400,000 tonne fine tailing (0.5 Bg/g) blended with 125 tonne filtrate solids (1 Bg/g) equates to 2.4 Mtonne of tailings @ 0.5 Bq/g. In conclusion, even with ultra conservative considerations, the DAF solids, from a radioactivity perspective are a negligible component of the total solid component for disposal.

The fine tailings (0.5 Bq/g U+Th) are not classified as 'radioactive material' under the Victorian *Radiation Act (2005)*.

- *radionuclides may be present within the treated water being discharged into the Mitchell River and the potential to affect the beneficial uses of that surface water resources; It is understood the only treated water discharged to the Mitchell River will be from the fresh water dam related to the DAF process.*

DB Response:

The only treated water discharged into the Mitchell River will be from the freshwater dam collecting water processed from the DAF. This water never comes into contact with HMC processing plant water, only topsoils, and overburden. As demonstrated above, the radionuclide contribution to already existing natural radioactivity within the rainwater can be considered negligible.

It is recommended that any water released from the freshwater dam to the Mitchell River undergo laboratory testing for radionuclide content prior to release.

- *radionuclides may be present within the discharge of water into the aquifer beneath the site and the potential to affect the beneficial uses of that groundwater.*

DB Response:

It is my understanding the Boisdale aquifer – the main potable water source - is located 15 km from the Project area, and is disconnected from the local water table that intersects the ore body. This local water table beneath the site is of low yield and not of use for agriculture or other purposes.

Irrespective, the radionuclide concentrations in the tailings deposited in the Tailings Storage Facility and then returned to the mine void (0.5 Bq/g) (RAR, Table 11) will be lower than that of the originally mined ore (0.8 Bq/g) (RAR, Table 12). The Fingerboards primary mineral separation process is a purely mechanical and gravimetric process, with no chemical or thermal alteration of the mineral. Consequently, the potential for migration of radioactivity from the mineral into the local water table in the area would be similar to the existing conditions that occurs naturally with the presence of the heavy mineral ore deposits. The radionuclides are highly insoluble and even if the material is returned to the TSF as a slurry, the radionuclides will not preferentially mobilise more readily compared to when they are undisturbed in the orebody. Radioactivity is already present naturally in ground water supplies in the region (refer 9.2.7 of RAR for the full detail).

It is important to recognise that based on the radioactive concentration of the Fine Tails being returned to the mine void (<1 Bg/g), it would not otherwise be recognised as 'radioactive material' in Victoria. As a stand-alone disposal operation it would not be subject to regulation as a radiation practice under the *Act*.

- *whether the infrastructure of the DAF treatment plant could become irradiated such that when it comes to the decommissioning of the DAF and mine the concrete, steel etc would need to be buried within the mine voids.*

DB Response:

The DAF treatment plant, and any other process equipment, will be 'irradiated' as result of radiation emitted from the heavy minerals in the ore. However, the irradiation cannot result in the DAF plant, the processing plant, or any other structural materials becoming a source of radiation itself.

All equipment is likely to have surface contamination as a result of operations and will need to be adequately cleaned at the time of decommissioning, to allow disposal as general industrial waste. This process will be integral to the Radioactive Waste Management Plan to be drafted.

**SUBMISSION 716**

The radiation issues raised by this submission are outlined in Section 3.10 including 'Table 10: Radiation Technical Assessment' of the Submission.

The technical reviewer provided responses in relation to the questions posed (*shown in italics below*), and where gaps were believed to exist, comment was also provided by the reviewer. I have extracted relevant comments below and provided a response to them.

1. Have appropriate investigations been undertaken to characterise natural background radiation levels within the project site and broader project area? - ***Partially***

   Gaps/Comments: *It is suggested that additional baseline monitoring be conducted to better quantify baseline levels as follows:*

   ***Radon and Thoron*** *- Passive monitoring of radon and thoron is useful for long term trends when aligned with the seasons and also over a number of years. Real time radon and thoron monitoring*

*equipment is available and able to better characterise diurnal variation for each of the seasons. Ongoing passive radon and thoron monitoring on a seasonal basis at key locations.*

| |
|---|
| DB Response: Agreed in relation to passive monitoring (refer Statement, paragraph 8.7). I am aware real time monitoring is available. Kalbar may consider undertaking this to assess regional diurnal variations over a seasonal period. |

***Radionuclides in Flora*** *– Radionuclide analysis of flora and crops should be conducted (note that the presented data is calculated from soil concentrations)*

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| DB Response: Agreed, refer to Section 8.8 of this Statement. |

***Radionuclide Analyses*** *– Consideration of all long-lived uranium and thorium radionuclides should be conducted. The suggested radionuclides are: U-238, Th-230, Ra-226, Pb-210, Po-210, Th-232, Ra-228, and Th-228*

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|---|
| DB Response: Radionuclide assessment for additional radionuclides will be undertaken for a selection of samples collected (refer Statement, paragraph 8.5) |

***Airborne Dust Monitoring*** *- High volume dust sampling was undertaken for PM10 material*
*For radiation dose assessment, it is usual to consider TSP. Consideration of the ratio between TSP and PM10 concentrations should occur.*

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| DB Response: My recommendation is for the collection of TSP filters for airborne radioactivity assessment, rather than undertake PM10 assessment or rely on TSP/PM10 ratios. PM10 results for U and Th were reported in the RAR (section 5.7) as results were available and were integral to the heavy metal EPA Air quality study conducted separately.<br>Recommendations for airborne dust monitoring for TSP are outlined in Statement, paragraph 8.6. |

2. Has the EES reasonably assessed the likely radiological content and impacts of the heavy mineral ore, HMC concentrate, tailings and any other waste materials? ***- Yes***

   Gaps/Comments*: It is suggested that regular monitoring of the ore, HMC concentrate and tailings be conducted to confirm the classification of the materials.*

| |
|---|
| DB Response: Agreed. |

3. Has the EES reasonably assessed potential radiological risks to the environment, biodiversity values and human health associated with the production, on-site storage, transportation, and storage at the port? ***- Yes***

Gaps/Comments*: It is suggested that a draft RMP and RWMP be prepared, outlining the operational systems measures and controls for radiation. It is noted that these documents are part of a later secondary licencing process, however a draft at this stage is useful for providing confidence of the document's contents.*

| DB Response: Agreed. |
|---|

4. Has the EES described appropriate methods and strategies to demonstrate the radioactivity of tailings and waste materials stays within environmentally acceptable exposure levels? ***- Yes***

Gaps/Comments*: It is suggested that regular monitoring of the ore, HMC concentrate and tailings be conducted to confirm the classification of the materials.*

| DB Response: Agreed. |
|---|

5. Has the EES utilized appropriate methods to undertake the radiological impact assessment? ***- Yes***

Gaps/Comments: *It is noted that the ICRP have recently published new dose factors for naturally occurring radionuclides. The factors are for inhalation and ingestion of radionuclides, and also for the inhalation of the decay products of radon. The factors apply to occupational exposures only at this stage. Dose factors generally need to be approved by the local authority and adopted in local legislation. It is understood that the new factors are yet to be adopted in Victoria. It is suggested that the potential doses be re-assessed using the latest dose factors. This will provide a "best practice" assessment of doses. Note that this is not expected to significantly change the final assessed dose, however it is appropriate to consider the new dose factors.*

| DB Response: Estimates of potential occupational doses are an important component of the RMP still to be drafted. The RMP will require approval from the Victorian Department of Health and Human Services (DHHS) prior to a Management Licence being issued to Kalbar.<br>It is agreed that the latest ICRP dose conversion factors (DCF) should be used to calculate potential occupational doses. These factors would be used in-lieu of the expectation they will be adopted in Victoria in due course. It should be noted that all dose calculation methodologies, including DCF, must be approved by the DHHS. |
|---|

6. Are the recommended radiation related controls adequate for the go-ahead project? ***– Yes***

Gaps/Comments: *It is suggested that a draft RMP and RWMP be developed. This will provide assurance that the radiation controls are captured and incorporated appropriately. However, it is noted that approval of the final RMP and RWMP documents is part of a secondary approval process and it not necessary for the final RMP or RWMP to be developed at this stage.*

| DB Response: Noted and agreed. |
|---|

7. Are the proposed Radiation Management Plan (including radioactive Waste Management Plan) and Radiation Transport Management Plan adequate and appropriate? – ***Yes, with suggestion***

Gaps/Comments: *Elements of a final RMP and RWMP are available in the EES document and appear to cover the requirements outlined in the ARPANSA Mining Code and other international guidance.*
*The documentation contains extensive references to the transport of mineral concentrates and a commitment to ensuring that it is transported in accordance with applicable requirements of the Code of Practice for Safe Transport of Radioactive Material. It is suggested that a draft RMP, RWMP and RTMP be developed. This will provide assurance that the radiation controls are captured and incorporated appropriately.*

| |
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| DB Response: Agreed. |

## GENERAL COMMENTS

**General health impacts** - There were several general issues raised in relation to the health impacts relating to radiological hazards from the project.

It is acknowledged ionising 'radiation' and 'radioactivity' causes angst generally, not only associated with the mining industry, but in the wider community in general. This was evident in many of the submissions. Unfortunately, the topic is often misunderstood and misrepresented.

**Submission 68**
*The risks to health from the contamination arising from the mine are real and significant. Cancer is already a major health issue in the 21st century and has major impacts on the economy and society.*

**Submission 813**
*This project has already seen significant anxiety in the local community around potential for radiation increases.*

DB Response:

Health effects from radiation exposure in the workplace and general community are risked based. That is, the greater the levels of exposure, the greater the level of risk of an effect (RAR, Section 3).

This has been explained in the RAR, and I have responded to specific issues raised in the submission responses to follow.

**Thorium -** There were several submissions in regard to **thorium**, and its radiological impact on human health.

**Submission 268**
*Thorium*
*• Thorium is widespread in the environment and most people are not exposed to dangerous levels of the metal.*
*However, people who live near Thorium mining areas have increased risk of exposure especially if their water comes from a private source.*
*• individuals exposed to Thorium have an increased risk of bone cancer, thorium is stored in bone.*
*• there is research evidence that inhaling Thorium dust increases the risk of lung and pancreatic cancer.*
*• the primary ways people are exposed to Thorium are through inhalation, ingestion, and absorption through the skin.*

**Submission 733**
*The U.S. National Cancer Institute states that Thorium for instance, once ingested cannot be removed from the human body: "there is research evidence that inhaling thorium dust increases the risk of lung and pancreatic cancer. Individuals exposed to thorium also have an increased risk of bone cancer because thorium may be stored in bone."*

DB Response:
Thorium, specially the radionuclide Th-232, is naturally occurring and is present in almost everything used in our daily lives. Radioactive materials, much like chemical substances, can be hazardous. But this risk will be heavily dependent on the concentrations present. Despite the hazards being described in many of the submissions, no concentrations were referenced, nor were they related back to concentrations likely to be encountered on the Fingerboards project.

The ore being extracted does contain radioactivity, including thorium above concentrations found in surface soils, but still has a low total activity concentration (0.8 Bq/g) (RAR, Table 11), which is less than the 1 Bq/g threshold for constituting 'radioactive material' under Victorian radiation legislation. The radioactivity of overburden (0.025 Bq/g) (EES, Appendix A002, Table 7) is equivalent to naturally radioactivity levels present in common garden soil.

It also needs to be recognised that radioactive materials are not being introduced or concentrated for return to the environment, they are integral to the heavy mineral that is being extracted as saleable product. A fraction of the existing radioactive material is being returned to the mine void where it originated from.

**Monazite, zircon and other minerals** - There were several submissions on the health hazards of various minerals contained within the ore. Some submissions referenced MSDS data. Some submissions referenced hazards associated with other different types of operations involved with the extraction of rare earths and secondary separation of mineral products. Some comments were as follows:

**Submission 268**
*Tailings Dam – Thorium is a principle radioactive component of Monazite which has potential to leach into water bodies – including drinking water supplies. Long term presence of thorium residue in tailings can take thousands of years to disperse.*

And..

*Human Health - The mined ore contains:*
*Monazite*
*• Mixed into tailings disposed of as radioactive waste due to its content of significant uranium and thorium.*
*• The National Cancer Institute claims that Thorium is a major component of Monazite*

**Submission 413**
*There will be radioactive substances being mined including rare-earths, undisturbed these substances do not pose a health risk but when excavated and crushed concentrated toxic dust will be generated.*

**Submission 423**
*Apart from the elements listed, the minerals in which they occur may themselves be hazardous. The rare earths are found in the minerals monazite and xenotime (Appendix A002 p21) Both commonly contain the radioactive elements thorium and uranium, which have been detected in the*

*assay. Xenotime crystals are brittle (Wikipedia) and hence likely to fracture during mining and hence contribute to the dust. Monazite is extremely toxic if inhaled or ingested.*

**Submission 516**
*8. Radiation and Related Contaminants..*

**Submission 744**
*- Radio-Active substances including dormant Rare Earth Minerals that are toxic to humans when exposed, crushed and altered*

**Submission 813**
*Monazite is one of the minerals identified in the Glenaladale deposit. Due to the effects on the environment by radionuclides, Monazite mining has been banned in China and America.*

DB Response:
The Fingerboards Project involves primary separation only, separating the ore into magnetic and non-magnetic concentrate. Total activity concentrations of the HMC will not exceed ~10 Bq/g.

Activity concentrations associated with down-stream mineral separation industries, including secondary dry separation, and rare earth extraction and zirconia extractions, are substantially higher, up to 250 Bq/g, posing a much greater hazard to human health and the environment (refer ARPANSA Technical Report 165 section 3.4). Many of these processes incorporate dry, chemical and/or thermal processing. These hazards should not be confused with potential hazards associated with primary mineral separation proposed for the Fingerboards Project.

Monazite is a rare earth mineral containing 5-7% thorium and can have an activity concentration of 200-300 Bq/g (RAR, Table 9). From a radiation protection perspective, it is the mineral of most interest in the mineral sands industry, capable of delivering the highest radiation dose if present in these concentrations. However, on the Fingerboards Project monazite it is not being separated from the HMC and will not be concentrated, with total activity concentrations remaining less than 10 Bq/g.

**Toxicity Levels** - One submission did attempt to explain the risk in terms of the toxicity levels of the elemental compositions, and the various radiotoxicity of suspected radionuclides present:

**Submission 639**
*The submission outlines toxicity values of heavy metals and radionuclides, expressing they are of concern.*

DB Response;
The submission states that a full list of radionuclides have not been provided by Kalbar, a reference to the principal natural decay chains U-238 and Th-232 present in the ore. Activity concentrations of U-238 and Th-232 are calculated from the U and Th mass concentrations in the ore (RAR, Section 6.4). U-238 and Th-232 are only the 'head of chain' radionuclides and will have decayed to many other radionuclides (progeny) that will be present in the ore, product and tailings. Some of the key radionuclides are reported throughout the RAR including Ra-226, Pb-210, Ra-228 and Th-228. In the natural environment, and for the Fingerboards Project, radionuclides are in 'equilibrium' with the head of chain, and as such are considered to have activity concentrations equal to U-238 and Th-232. Consideration of the progeny is important for dose assessment purposes by a radiation professional, however this level of detail of discussion was not considered warranted for discussion in the RAR.

Radiological impact assessment is based on dose received (mSv) and not the 'toxicity levels' referenced in the submission, as the exposure pathways are of importance. The submission provides lots of information on toxicity levels and carcinogenetic levels, however it hasn't been related back to potential doses for Kalbar operations or members of the public based on key exposure pathways. Furthermore, the low radioactivity concentration of the ore has not been considered.

I am unfamiliar with the intricacies of the US radiation regulatory system referenced throughout the submission. Australia has adopted the International Commission of Radiological Protection (ICRP), with the approved methodologies outlined in Australian ARPANSA guideline documents. ARPANSA guidelines were followed to calculate the potential doses in the RAR (RAR, Section 9). The US has not adopted the international ICRP regulatory framework.

**Industry documents** - One submission referenced an older Australian paper discussing the Mineral Sands Industry in Australia:

**Submission 893**
*Regarding radiation. I would suggest that both Kalbar and the advisory committee read a paper written by G.S. Hewson and B. M. Hartley and although an older report, radiation is still radiation and paints a very different story of the risks associated with mineral sands mining and radiation. A very different story to Kalbar's.*

DB Response:

The Hewson/Hartley paper was based on the mineral sands industry of the 1980's – a lot has improved from a radiation protection perspective since then. Industry changes have included improved control of external radiation exposure in circuits where monazite is handled, and improved methods for dust control including containment and removal of suspended particulate by ventilation or similar means.

Refer to the ARPANSA document, ARPANSA Technical Report 165 section 3.4 which also references Hewson/Hartley paper. The ARPANSA report also provides a more current summary of the mineral sands industry in Australia.

## REGULATORY FRAMEWORK CONCERNS

**Regulatory Framework** - There were several comments suggesting there was an insufficient radiation regulatory framework in Victoria that would apply to operations:

**Submission 813**

Chapter 5 (human Health) Appendix 10: Health Risks Associated with Mineral Sands

*Victorian legislation pertaining to Mineral Sands Mining that aims to protect the health and safety of employees and nearby residents (sensitive receptors) is limited. Whereas there is publicity strongly promoting mineral sands mining in Victoria. The documents mainly used for this paper include: Safe Work Australia, "Guidance on the Interpretation of Workplace Exposure Standards for Airborne Contaminants" April 2012; the Occupational Health & Safety Act, 2017 (Victoria), and a Western Australian Industry Regulation fact sheet on Mineral Sands Mining or processing, 2018.*

DB Response: The above-mentioned documents are not relevant to radiation safety and its regulation in Victoria.

The most important radiation safety regulatory documents have not been acknowledged in the submission document. Practices using radiation and radioactive sources are regulated by a dedicated regulatory body (see further response below).

**Submission 268**

*Radiation - Radiation hazard levels are determined by reference to Codes of Practice and standards set by National and international scientific and medical bodies, implementation of standards depends on complementary State and Commonwealth legislative arrangements, the enforcement of environmental and radiation standards is a State responsibility, the administrative arrangements established by the States are fragmented as they consist of provisions contained in mining, radiation health and other legislative enactments.*

**Submission 488**

*The Australian Radiation Protection & Nuclear Safety Agency has various codes of practice covering radiation dose limits, transport of radioactive materials and management of by-products generated by heavy mineral sands mining. Kalbar states 'adherence to these codes of practice MAY BE included as conditions of a license issued for the project' (EES Radiation Brochure, pg.8). MAY BE?!*

DB Response: 'May' was used as neither I nor Kalbar are in a position to stipulate regulatory licence conditions. However, the Regulator has confirmed the Mining Code will apply, and many aspects of the Transport Code will apply.

DB Response:

Radiation practices are regulated on a state by state basis, rather than nationally.

There is a well-defined framework in Victoria for practices that use or possess radioactive material including mineral sands operations. This is discussed in detail in the RAR, Section 7.2.

The Victorian *Radiation Act* 2005 and associated 2017 *Regulations* - apply to all radiation practices in Victoria. It encompasses the protection of workers, members of the public and the environment. It is enforced by the Department of Health and Human Services, who will issue a Management Licence to Kalbar for the Fingerboard operations.

The second most important document is the *Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (RAR, Section 7.5*)*. This Code, applicable to the mineral sands industries, will be stipulated as a Condition of licence applicable under the Act. There is also an associated Guide which outlines recommended dose assessment methodologies based on international best practice.

Failure of Kalbar to comply with the Management Licence will be an indictable offence under the *Radiation Act*.

## BASELINE ASSESSMENT

**General comments** - There were some submissions questioning the **baseline data** collected by SGS. In some instance, I believe there was a misunderstanding of the purpose of the baseline assessment, and how the data was to be interpreted:

**Submission 837**
*P39 Radionuclides. The Radiation survey is misleading in stating that radionuclides are found in the surface soils as the ore body is exposed in some surface areas. This as a fact may be true but is also misleading as it ignores the logical probability that exposing more of the ore body will expose further radionuclides.*

**Submission 893**
*Kalbar states in the project area north of the Bairnsdale- Dargo road that in this area, levels of radiation are substantially elevated compared to the global average for uranium and thorium, likely due to the ore body occurring at, or closer to, the ground surface.*
*Excuse me for not being an expert in radiation; however, would that not mean that the ore body buried deep in the ground would also be substantially elevated?*

DB Response:

Natural radioactivity and background radiation is everywhere. It is present in the soil, in vegetables that uptake these radionuclides from the soil, it is in our drinking water, in the ground water, and in the air we breathe (in the form of radon gas and airborne dust).

Importantly, these levels vary considerably depending on not only location, but also, seasonally (e.g. radon and groundwater). It is extremely important to recognise local conditions, and the radiation doses the community currently receive as a result of natural radioactivity. Importantly, the ranges and variations of background levels pre-mining need to be fully understood.

The baseline assessment needs to accurately capture this data. It allows the project 'impact' to be assessed above these existing baseline levels and allows differentiation from the ranges present naturally.

Part of the baseline assessment also involved characterisation of the radioactive content of the buried ore body and proposed waste streams during Fingerboard operations (RAR, Section 6).

Existing baseline (pre-operation) vegetable intake doses (RAR, Table 17) are calculated based on surface soil samples collected from the farming district. However, estimates of potential doses arising from dust, water intake, etc during operations (RAR, Section 9) are calculated based on the radioactive content of the buried ore, under the assumption it will be fully exposed at the surface during the mining process.

None of the sample results collected from Perry Gully have been used in any of the radiation dose estimates to workers or members of the public reported in the RAR.

**Baseline Tank water** – One submission discussed baseline data collected from rainwater tanks:

**Submission 639**

*28th January 2018 I conducted a series of 24 Dam and Tank water Tests in the vicinity of the proposed Kalbar Mine Site…The purpose was to set a baseline for local residents rainwater tanks ..so that any tank pollution could be linked back to mine operations.*

*The results from the Lab analysis indicated only 1 dam was outside the ADWGL limits. The rainwater tanks were in pristine condition…*

DB Response:
As laboratory results have not been reported in the submission, it is unclear if this refers to radioactive content or heavy metals in the water. It is also unclear if Australian drinking water limits are being referenced considering the remainder of the document refers to US regulatory limits. Baseline levels are best established using multiple samples to allow for possible seasonal variations.

**Validity of Baseline assessment** – Some submissions questioned the validity of the baseline data, and the how it could be used in Kalbar's favour.

**Submission 813**

Chapter 5 (Human Health) Page 133 comment:-

*It would surprise many that sites used for baseline radiation levels include Bairnsdale, 25 kms from the mine, and near a wombat hole in the Perry Gully. These locations do not reflect where local people (i.e. within 5 km of the mine) live and work. Inclusion of those locations significantly increased the average baseline radiation levels.*

DB Response:
I have presumed this comment relates to gamma survey as per RAR, Table 1. If so, measurements were conducted both within the mining area, and outside the mining area. Results from each area were averaged purely for reporting convenience only – not for identifying definitive remediation criteria. As per the RAR, 33 measurements were conducted outside the mining area, all with 2 km spacing, the majority within 5 km of the mine (locations depicted in RAR, Appendix B).

The Perry Gully is reported in the RAR as elevated radiation levels were identified during the surface gamma survey. It is an important natural phenomenon, of relevance when considering Mitchell River impacts (refer to my responses to submissions relating to 'Dust Impact on Surface Water Quality' below).

**Submission 854**

Submission 854 makes the suggestion that based on existing background levels, modelled criteria, and estimated impacts were modelled to Kalbar's favour, and thus Kalbar will make the argument that no further radiation monitoring will be conducted.

DB Response:
This is incorrect. Kalbar will be accountable for complying with a radiation monitoring program approved by the Victorian regulator (DHHS).

Baseline radiological data has been obtained based on laboratory analysis of collected samples undertaken in a NATA Approved laboratory. The RAR impacts are 'modelled' on the best data available, and with extremely conservative inputs used. Importantly though, irrespective of the low impacts, Kalbar will still need to undertake rigorous workplace and environmental monitoring in

accordance with an approved radiation monitoring program to demonstrate controls are effective. Failure to so would be in breach of the Victorian *Radiation Act 2005*.

**Baseline Crop assessment -** Two submissions questioned the baseline crop uptake assessment.

**Submission 765**
*What's in the Dust and is it safe? SGS Radiation Services stated they assessed the risks based on analysing a small number of soil surface samples (Horticulture Study p 36). Surface soil samples will be very different to what will be excavated 45m below ground.*

**Submission 516**
*Finally, a puzzling feature of Kalbar's EES Radiation Information Brochure (Page 5) is its description of the testing of the uptake of radionuclides to crops. The uptake rates were calculated for composite samples taken in 2018 from five areas within the farming district. The radionuclide content in the crops was stated to be well below naturally occurring levels found in soils worldwide. This finding is of little moment as it relates to sampling of soils in areas not yet exposed to the impact of mining.*

DB Response:

There has been a misinterpretation. Existing vegetable intake doses (RAR, Table 17) are estimated based on surface soil samples collected from the farming district. However, estimates of potential doses arising from vegetable intake during operations (RAR, Table 18) are calculated based on modelled deposition data and the radioactive content of the buried ore, under the assumption it will be fully exposed at the surface during the mining process.

*Similar observations can be made in relation to air quality sampling carried out between June 2017 and September 2018. The fact that uranium and thorium concentrations for dust samples were at or below the detection levels of analysis also only describes air uncontaminated by dust released from mining.*

DB Response:

Baseline radioactive dust levels are reported in the RAR. Radiation doses to workers and members of the public will require calculation by Kalbar considering the resuspension of ore, products and tailings assuming it is exposed at the surface during operations.

Two submissions raised concerns with water runoff:

**Submission 837**
*Loss or degradation of aquatic and terrestrial ecosystem from elevated levels of radionuclides in surface water runoff from stockpiled overburden*

**Submission 546**
*Runoff from the mine site, despite mitigation measures outlined by the proponent, will cause sediment and toxic radioactive substance to enter the river systems.*

DB Response: Refer to Appendix F, *Submission 514 – EPA* for responses relating to the water run-off and the DAF Plant.

Two of the submissions addressed concerns over occupational exposure of personal from the operations:

**Submission 219**
*As an Occupational Physician, I deal with the occupational and environmental impacts of industry and occupations on the health of workers. Although the EES is directed to the environmental impact on the country and nearby residents rather than the employees of the mine, the legislated operational requirements and standards applied to protect the health of workers will logically be the same as those that must be applied for the protection of the health of the community impacted by the proposed mine.*

**Submission 752**
*Thorium is an Alpha and Beta emitter which will primarily be a hazard for the workers on-site, as it is high energy but has little potential to penetrate the skin but may be inhaled or ingested. It is clearly associated with a higher risk of lung cancer than in the general population. This has been quantitated and written up in the medical literature across several continents where mineral sand mining is undertaken.*

DB Response:

Agreed. Alpha and beta emitting radionuclides, including Th-232, do present a greater internal exposure risk (inhaled or ingested) rather than an external exposure risk. Workers are likely to be more exposed than a member of the public as they will be potentially subjected to higher airborne concentrations during mining and primary mineral separation operations. As a result, their risk of a long-term stochastic effect occurring, including lung cancer, will be higher.

*The Radon decay pathway also contributes radon gas and radium (gamma emitter) which may be inhaled and is also water-soluble. The other key radiation risk is to the lens of the eye, where cataracts may be generated.*

DB Response:

Correct, but the risk is dependent on the concentration. Cataracts are an acute effect only evident after very high radiation exposures. Cataracts are not considered a risk on the Fingerboards project based on the low radioactive concentration of the ore and that of the HMC.

*ARPANSA (August 2020) has recommended that all states provide dose records for Individual workers, to a National Dose Register which would maintain the record for at least 30 years or until the exposed worker turns 75. This is important, particularly as this mine is only expected to produce for 15 years, but the health effects for workers are not over when the mine closes.*

DB Response:

Irrespective of the National Dose Register (which is still evolving), Kalbar is required to calculate worker doses and maintain records for the duration as stipulated in the submission. Record keeping requirements are an important component of the pre-approved Radiation Management Plan (RMP).

*Currently, the limit is not more than 1 mSievert annually averaged over 5 years, for the general population. For occupationally exposed workers this is 20 mSievert (but no more than 6 mSievert for 16-18 yo workers)*

DB Response:
The 1 mSv and 20 mSv referenced are upper limits only. Kalbar must maintain all doses to 'as low as reasonably achievable' (ALARA), with social and economic factors considered. This 'Optimisation' is in accordance with the regulatory requirements, and discussed in detail in the RAR, Section 8. The 6 mSv limit is not applicable in Victoria.

*If this project were to go ahead, there will need to be a mandated, strong management plan that details responsibility for radiation training and work protocols, reporting mishaps, worker dosages monitoring, transmission of results to ARPANSA and response to high dosage readings. The risk is that the actual on-site works will be subcontracted out to employers who may not be aware of the radiation risks and management. As the Hotel Quarantine system has demonstrated, subcontracted workers may not fully understand or implement the rules they are supposed to be working under.*

DB Response:
Ongoing training for the entire workforces will be an important component of the RMP.

*The supporting information from Kalbar does not mention dosage monitoring of workers, but rather monitoring at various places on site. This will not adequately monitor the actual dosage of radiation received by each person. Radiology department staff in hospitals wear monitor badges. Surely something similar could be provided for staff members? This should also include truck drivers, transporting concentrate.*

DB Response:
In addition to area gamma monitoring, the Kalbar workforce and contractors will be required to wear approved personal monitoring badges, similar to those worn in hospitals, to assess external doses. An important aspect of the radiation monitoring program.

*Outsourcing the training and risk management for health and radiation monitoring for workers and those involved in transport, is a dangerous way to proceed, for these workers. The company must at all times be accountable for long term health effects on workers.*

DB Response:
Irrespective of how the training is delivered, Kalbar will hold the Radiation Management Licence under the *Radiation Act (2005*) and will ultimately be accountable for managing radiation safety associated with the Fingerboards operations.

It is likely the transport company will have their own licence issued under the *Act.*

## TRANSPORT

**General -** Comments were provided questioning the radiological impact to members of the public arising from the transport of heavy mineral product.

**Submission 777**
*Similar concerns about community and my exposure to radiation to via the transportation and freight of waste and mine products in towns. Even if it is within accepted limits, this is still an added exposure route to already existing methods, which residents did not move to this region for.*

**Submission 813**
*Kalbar and their paid consultants have minimised the very real risk to long-term human and environmental health … as well as transportation of dangerous radioactive materials and potential of exposure to residents and travellers.*

DB Response:
The radiological impact on a member of the public arising from transport of the HMC is considered negligible as outlined in the RAR, Section 9.1.6.

Radioactive materials used for medical and geophysics testing purposes, with a lot higher radioactivity, are transported on our roads daily, including regional Victoria. Often a member of the public would be unaware of their presence on the road.

**Containment** – Some submission raised concerns on the containment of the product for transport.

**Submission 219**
*The dust dispersed by the trucks, and the dust from the outside of the containers of the product on either trucks or train, has the potential to pollute with radioactive dust along the transport routes through the towns and city.*

**Submission 763**
*Radiation exposure via dust contamination during transport has also not been investigated or evaluated as it has, again, been incorrectly assumed that all ore carrying trucks will be sealed, preventing any dust from escaping, when in reality truck 'tarps' only reduce not prevent dust from escaping during transport.*
*Risks to community health posed by dust escaping from trucks was not considered or evaluated by the EES, as it has been incorrectly assumed a 'truck tarp' will suffice in providing 100% containment of these toxic materials.*

DB Response:
I am advised by Kalbar they will not be using 'truck tarps' to seal road transport vehicles. Either sealed rota boxes or lined bulk containers will be utilised, dependant on the receiving ports capabilities.

In relation to surface dust, there will be strict controls in place to ensure vehicle are not leaving site with surface contamination following loading. Radiation contamination monitoring of the outside of vehicles before leaving site will be an important component of the radiation monitoring program for Kalbar.

**Regulatory requirement –** One submission raised concern on the legitimacy of the dose estimates, and placarding requirements of the vehicles.

**Submission 813**
– Chapter 5 (Human Health).
Page 146 - Radiation levels in HMC transport to port underestimated.
*The proponent has told people the trucks (or rail carriages) will contain about 5% radioactive monazite yet they state that those trucks or carriages will not have to be placarded. They appear to be relying on an ARPANSA publication on radiation exposure from the transport of mineral sands. However that publication specifically referred to sands where monazite wasn't part of the load and in fact had been treated as a waste product after processing and returned to site. (Calytrix Consulting, 2008)*

DB Response:
The requirements for placarding will be dependent on the total radioactive content of the HMC, not purely the monazite content. Kalbar have determined this content from metallurgical test work (RAR, Section 6.4). Based on this content, the Victorian radiation regulator (DHHS) providing the Management Licence to Kalbar and the transport company will make the decision on placarding requirements. It is not a decision for Kalbar nor I, nor will any other technical report dictate this. The DHHS will use guidance material as outlined in the national ARPANSA *Code of Practice for the Safe Transport of Radioactive Material* – which will be a condition of Licence.

I suspect that placarding may not be required based on activity concentrations of the HMC being transported.

These matters are addressed in more detail within the RAR, Section 7.7.

**Loading facility** – One submission raised concern over public access to loading facilities.

**Submission 763**
*Also, as elevated radiation levels are likely to occur at areas of spillage adjacent to monazite loading and storage facilities, it may be necessary to have a system of controls to restrict the public and nearby landowners from having contact with some parts of former mine sites. The EES currently make no such provision, and should.*

DB Response:
The HMC loading and storage facilities will be on site operational locations and restricted from access by members of the public. Remediation and rehabilitation of all operational areas will be required by Kalbar progressively during the Project.

Some submissions raised concerns in relation to airborne radon gas exposure

**Submission 813**
*Radioactive gases Residences within proximity of the project area will be impacted by uncontrolled gases from tailings and overburden. How is this cancer-causing risk to be avoided?*

**Submission 837**
*P16 - Adverse health impact from inhalation of thoron and radon gas...*

DB Response:

Radon and thoron gas is naturally occurring and is measurable throughout the region. Of importance is whether concentrations are going to be elevated as a result of Kalbar operation, whether levels are going to be distinguishable from natural variations that are present, and if so what will be the radiological health impact.

The potential levels of radon and thoron gases in mineral sand mining and separation will depend on the rate at which it emanates, or escapes, from the ore or mineral product, and the level of ventilation in the area where these materials are handled, produced or stored. The physical structure of the heavy minerals mitigates the quantities of radon escaping or emanating from the sand grains and is, on average, an order of magnitude below emanation rates associated with rocks and soil. Furthermore, any radon or thoron gas released to the atmosphere from an ore body or stockpile will be rapidly diluted and dispersed. Therefore, in an open pit during mining, radon and thoron concentrations will undergo mixing and will disperse in the environment. Radon/thoron exposure is deemed an insignificant exposure pathway to members of the public (refer RAR, Section 9.2.2).

Baseline levels are discussed in RAR Section 5.8. Levels are also discussed in Section 4 of this Statement.

The majority of radiation-based comments in the submissions have related to radioactivity in **airborne dust**. This section addresses general comments with responses provide.

(Dust related concerns specific to vegetable uptake, and impact on drinking water are addressed in further sections).

**Submission 370**
*My family and I live 2.5 km from the proposed site, we 100% rely on rainwater from our roof run off and we have farm country. If our water or land gets contaminated in any way by toxic dust, we along with all our neighbours will become income-less and displaced in the long term.*

**Submission 390**
*Once the mineral sands have been bought to the surface, the dust which is likely to be radioactive and can cause cancer will be exposed. Once these particles are made airborne by the strong winds that frequent the Lindenow Valley, this contaminated dust will pollute the very air we breathe. It will be inhaled and digested by human beings and animals in the Lindenow Valley Food Bowland all-over East Gippsland, possibly Australia wide.*

**Submission 484**
*Seeds and seedlings are watered regularly to encourage growth and dust only blows on the worst of days. That dust is from topsoil and very different to what is being dug up by the mine which will expose a number of heavy metals and radionuclides that are quite safe when sequestered in the ground but begin to change form as soon as they are exposed to oxygen and carbon dioxide.*

DB Response: Radioactivity won't change form once exposed to air. See further comments below.

**Submission 488**
*These dusts include respirable crystalline silica which causes lung cancer, radioactive radionuclides such as Thorium and Uranium, heavy metals, Arsenic, Chromium and Vanadium. Dusts travel long distances in high winds. There are documented cases of mineral sands dusts travelling over 20 km, and they can easily travel much further than that, given the particle dust size of some of their components is at pm 2.5 scale or less.*

**Submission 506**
*Dust. My family farm relies on tank water for drinking and showers and dam water for livestock. It also has an outdoor swimming pool. The reality is that dust from the mine will end up on my Father's roof, in the drinking water, in the dam, and in the outdoor pool. The EES has acknowledged there are radioactive substances being mined including rare-earths. Are the health effects of the radioactive dust known?*

**Submission 548**
*We do know the mine will create toxic, respirable silica and radioactive dust particles that kill life. These cancer causing particles…*

**Submission 564**
*Dust and contamination from the dust. The model in the EES shows that the dust on windy days, which locals know all to well can travel as far as Bairnsdale and beyond. We know that some of the substances being mined for have radioactive properties therefore the risk of these substances plus others substances travelling through the air, settling on water tanks, the ground on which children play and other various locations may have future health impacts.*

**Submission 600**
*Damage to public health from exposure to cancer-causing air born fine particulate matter risks an exploding long term health care crisis.*

**Submission 652**
*There are real health concerns from the contaminated and radioactive dust.*

**Submission 737**
*I am also concerned about dust contamination and the health risks posed by it.*

**Submission 745**
*Radioactive Material*
*If Kalbar were to mine they would expose the community to radioactive substances. The dust generated from excavation would travel to the nearby Heritage Listed Mitchell River and The Lindenow Flats. The Mitchell River Valley produce 30-40% of Melbourne's vegetables. The radioactive material poses a health risk to the local community directly from the travelling dust and to the wider Victorian population. Dust travels far and an adequate risk mitigation has not been proposed (dampening with sprinklers is not a satisfactory risk mitigator and has flow on contamination issues). The IAC have a duty of care to the community to ensure that an increased cancer burden is not placed on the community.*

**Submission 750**
*Kalbar's geochemistry report lists a number of radioactive and cancer-causing substances that will be present in the dust generated. Dust can travel far so this potentially could effect the entire district.*

**Submission 837**
*Loss or degradation of aquatic and terrestrial ecosystems from stockpiled concentrate. Even with mitigation measures in place no guarantee can be given that HMC from stockpiles will not find its way into ecosystems.*

**Submission 054.**
*Coating Lindenow township in radioactive dust (school children, cafes, shops, homes…)*

DB Response:

Two very important facts will contribute to low resuspension of radioactive dust into the air,

- Size - It is important to recognize that the ore being processed has an average particle size of 83 µm. The Fine Tailings entering the TSF and mine void is <38 µm, however this remains only 21% of the ore. For comparison, airborne inhalable dust is recognised as particulate which is less than 20 µm is size.

- Mass - The mineral sands contains radioisotopes of uranium and thorium. Both U and Th are extremely heavy with a specific gravity of 18 sg and 11.7 sg respectively (for comparison purposes, lead is 11.3 sg).

The above factors - **size** and **mass** - work heavily against resuspension of ore particulate into the air.

But if we consider worst-case and radioactive dust were somehow to become airborne, it important to also consider the third, most important factor - **radioactivity** content. The ore material has an activity concentration of approximately 0.8 Bq/g Total U+Th – low in radiation industry standards. This means that extremely large quantities would need to be ingested (swallowed) or inhaled to receive a notable radiation dose. Explained further as follows:

1. Environmental dust impacts aside for the moment, we should first consider the impact on the Kalbar workforce. The workforce will be in direct contact with the ore body and often in close contact with the higher radioactive concentration HMC product. It could be expected they would receive the largest doses of the 'community'.

2. Worker annual doses were estimated (RAR, Table 15) using internationally recognised methods, and conservative assumptions. The majority of doses are expected to be less than regulatory limit (1 mSv) set for 'members of public' and well below their 'occupational limit'. Additionally, of the total dose, only 10% is attributable to inhalation of dust compared to other pathways (e.g. gamma radiation). Why? Because the radioactivity concentration of the dust is so low. Irrespective, in the interest of ALARA (RAR, Section 8), Kalbar will be required to adhere to strict controls to avoid resuspension of dust, and will not be allowed to rely on respiratory protection to minimise doses. Importantly, it has been assumed **no respiratory protection** is worn in estimating worker doses.

3. Kalbar will be required to conduct intensive air sampling of the workforce, and high-air volume monitoring on the perimeter, and in the wider community to confirm effective controls are in place. All results will require regulatory reporting.

A potential inhalation dose to a member of the public off-site was also calculated (RAR, Section 9.2.1). The dose applied to a Critical Group assumed to be living on the boundary but readily applies to any member of the community living 1 km or 20 km from site. Extremely conservative parameters were used including:

- *The entire dust is only Ore* (and not overburden tailings or road dust which will have a substantially lower radioactive content)
- *A continuous dust concentration of 60 µg/m$^3$* (60 µg/m$^3$ corresponds to the PEM assessment criterion for PM10 as outlined in the Katestone report)
- *Exposure to the above conditions 24hr, 365 days per year*, with no consideration for periods not at the residence, or indoors (where concentrations will be reduced)

An inhalation dose of 0.029 mSv per annum was estimated, significantly less than the 1 mSv per annum limit for members of the public. In reality, a much lower inhalation dose would be expected.

**Monitoring techniques and particle size** - One submission commented on the air monitoring techniques to be adopted as part of the radiation monitoring program:

**Submission 214**
*Pg 11 - Radiation in fine particulates*
*While a radiation monitoring program to assess "environmental airborne activity concentrations" during all stages of operations was recommended, in Section 5.7 Airborne dust concentrations (SGS,*

*2020) it is reported that analysis of PM10 samples "… registered …" U and Th concentrations below the minimum detection level (MDL), and further, "… U and Th radionuclides, associated with sediments or heavy mineral ore, were present in concentrations less than the MDL.".*
*These findings suggest that alternative more sensitive analytical and/or sampling techniques should be utilised to enable detection and measurement of U and Th in PM10 to facilitate environmental monitoring and health impact assessment.*

DB Response:
Baseline samples of PM10 were analysed for total U and Th as part of the non-radiological air quality study for heavy metals, and thus were reported (RAR, Section 5.7). Some filters were analysed for gross activity where available.

However, HiVol sampling for TSP (total suspended particulate) will be the primary sampling technique for radiological exposure assessment, and a key component of the radiation monitoring program for Kalbar. Filters will be analysed for gross alpha and beta activity and enable dose assessment when required.

For dose calculation purposes a conservative dust size (AMAD) of 1 µm will be assumed – a regulatory requirement for members of the public assessment. (the smaller the dust size the greater the dose received) (RAR, Section 9.2.1). However, the radioactivity applied to the dose calculation will be obtained from TSP filters (that samples all sizes). This methodology is common in the radiation protection industry.

Sufficient baseline TSP collection and gross activity is still required and has been recommended in Section 8 of this Statement.

**General impact on Mitchell River** - Submissions were received on the concerns on the radiological impact on the Mitchell River:

**Submission 594**
*The proposed mine area is part of the catchment for the Perry and Mitchell rivers (which includes numerous creeks and natural watercourses such as Iguana, Moulin and Toms creeks) and subsequently the entire Gippsland Lakes system (a listed wetland). It would only take one, (I repeat one) episode of an environmental spill, (by water or airborne dust particles) to place the entire area, (bounded by Sale, Dargo and Lakes Entrance) at risk.*

**Submission 747**
*I am also concerned about radioactive particles getting into the water and the rivers into our beautiful lakes.*

**Submission 887**
Groundwater, river and lakes Contamination
*The source of the Perry River is just near the proposed mine site so contamination by dusts containing radioactive substances..from the mine will be definitely getting into the vital [Boisdale] Aquifer.*
And
*.. any contamination in the Perry River will end up in the Lake system.*

DB Response.

Surface waters contain a variety of metals including Radium. Radium is only present in radioactive form - as the radionuclide's radium-226 and radium-228. Radium will have leached into waters from natural uranium and thorium present in the ground for thousands of years. Ra-226/228 has been identified in the Mitchell River, creeks, and dams in the baseline assessment (RAR, Section 5.6).

Of significance is the fact that the ore body is currently exposed in the Perry Gully. During a walk-through survey conducted by SGS (in excess of 1 km) in the riverbed in May 2017, the orebody was apparent, both visually and with a radiation monitor. If the Perry Gully water feeds into the Mitchell River which feed into the Lakes system, then so does any soluble and insoluble radioactive materials currently present in the Gully. This is a natural phenomenon and is likely to exist elsewhere in the area where the orebody is exposed including Simpsons Gully. **However, it should be noted that existing radioactivity levels in the Mitchell River and other surface waters are still comparable to levels encountered elsewhere in Australia.**

In summary, irrespective of any mining operation, large volumes of water are produced during large rain events, in contact with considerable volumes of the exposed ore body in the Perry Gully, which flow into the Mitchell River.

The radiological impact of 'ug' quantities of Fingerboards-related airborne dust depositing in the Perry Gully waterway or Mitchell River is considered negligible.

**Impact on drinking water** - Submissions were received on the concerns on resuspended dusts settling in the Mitchell River, and impact on drinking water supplies provided from Woodglen WTP.

**Submission 054**
*Woodglen Reservoir is only 3.5km from the mine. This is the East Gippsland Water, water storage for Bairnsdale and district. While the EES has maintained that the radioactive dust from the mine will not contaminate the storage beyond allowable levels, without complete wind studies and modelling public confidence in the water will be eroded. What consideration has been given to the water solubility of radioactive minerals and the build-up of radiation levels in the water supply over the five, ten- or twenty-year life of the mine*

**Submission 663**
*A major water treatment plant and additional drinking water storage entered service at Woodglen in 2010, to ensure East Gippsland's water security. These storage ponds are exposed to the atmosphere and are in the direct path of prevailing winds blowing across the mine site.*
*The risk of dust and other airborne mineral particulates, including radionuclides, landing in the storage area ranks as a primary cause for concern.*

**Submission 860**
*East Gippsland's water storage facility at Woodglen, approximately 3 km downwind of the site could have Rare Earths ore dust entering this water. Were this to occur at 0.2 um in size and being both carcinogenic and radioactive, this material is impossible to remove form the water supply by filtration or other means.*

DB Response: I am unfamiliar with the filtration capabilities of the Woodglen WTP. However, the ore has an average size of 83 µm, and 21% is less than 38 µm. Based on the size distribution, the fraction less than 1 µm would be even lower. See below for further explanation

DB Response:

It is important to recognise when solids (dust) interact with liquids (the Mitchell River), it will result in two radioactive components - the insoluble fraction and the soluble fraction.

The insoluble component will settle out due to its weight or be removed by processing at the Woodglen WTP prior to drinking (RAR, Section 9.2.7).

The soluble fraction is of the most interest from a drinking water perspective. The minerals are naturally highly insoluble, particularly the U and Th, as demonstrated from leachability testing conducted (EGI 2020). If any component of the dust is of interest from a radiological health perspective, it is the Radium content, which is a by-product of U and Th decay series. (This is why radioactive Ra-226 and Ra-228 are supplementary tests outlined in the Australian Drinking Water Guideline if the 0.5 Bq/L screening criteria is exceeded (ADWG, 2011). An Australian government study looking at drinking water quality in Australia particularly assessed Ra-226 and Ra-228 levels [ARPANSA, 2008]). Thus, of interest would be any resuspended dust settling in the Mitchell River, and its impact on existing Ra-226/228 levels already present in the Mitchell River water.

Baseline monitoring of Ra-226/228 levels in local waterways including the Mitchell River have been conducted and are ongoing. A variability in radioactive content has already been indicated.

We must then consider (1) the volume of dust that could be deposited proportionate to the volume of water in the Mitchell River and processed by Woodglen WTP, (2) the low radioactive concentration of the dust deposited, (3) the proportion of the dust if deposited that will be radioactive ore (and not surface

soils or overburden), and (4) the fact the existing ore body of considerable size is already impacting on the Mitchell River water radioactivity levels (as discussed above).

As a consequence of all these factors, the consumption of water from the Mitchell River is considered an inconsequential radiological exposure pathway relative to other pathways assessed.

**Domestic rainwater** - Submission were received on concern from drinking rainwater that had been collected from property roofs in which resuspended dust had settled:

**Submission 094.**
*..The strong Sou-Wester winds that we get here will send dust directly over house and farm the impact on Health including lung disease from air particles, we also collect our drinking water from our roof's this is a huge concern.*

**Submission 202**
*The people on tank water! What are they going to do about the radiation that's in the dust, it settles on rooves and then we get rain and then it goes into the tanks? How can that be stopped? How are they going to reassure everyone there's no health risks involved?*

**Submission 408**
*Should that dust concentration settle on a house roof of 200m2 from which rainfall is collected into a 10,000 L domestic supply tank then 200 X 6gms = 1.2 kgs mine PM10 dust will enter that water tank. That dust will contain 1.2kg X 20mgs or 24mg of Thorium entering that water tank per annum. 1mg of Thorium has a Becquerel equivalent of 60 Bq. Hence that 10,000L tank will receive 1,440Bq per annum. After 5 years potentially 7,200 Bq will have entered tank at a potential concentration of 0.75 Bq /L. I believe the accepted standard is 0.5 Bq/L.*

DB Response:
The submitter has assumed incorrectly that the dust is totally soluble in water. In fact, thorium is very insoluble in water. Also, the '0.5 Bq/L criteria' mentioned must include all alpha and beta emitting radionuclides and must be added to the existing radioactivity levels in the water. Importantly the 0.5 Bq/L is a criterion for further water assessment and not considered a limit (RAR, Section 5.4). Solubility calculations are complex and dependant on many factors (see further response below).

**Submission 546**
*Tank water which supplies domestic drinking water to many households on rural properties in the area will be affected by contaminated dust.*

**Submission 849**
*I rely on tankwater and extremely concerned about contamination from dust*

**Submission 837**
*If radionuclides not a concern for proponent, it may be judicious to ask why rad levels have been found to be higher in farm water tanks near Mineral Sands Mines.*

DB Response:
Naturally occurring radioactivity is found in all solids and liquids at varying concentrations. Of importance is the quantities and the concentrations relative to background levels, specifically the insoluble component if consumed as drinking water. See additional comments below.

**Submission 887**
*Most homes collect rainwater to use as domestic drinking water. Contaminated dust will collect on the roofs of their houses, and will be washed into the drinking water. The potential health risk to these people has not been extensively looked at.*

DB Response:
See the comments above in regard to dust characteristics, and its impact on water quality in the Mitchell River. RAR Section 9.2.4 discusses the impact on consumption of drinking water originating from the Mitchell River. The same principles will apply to private water supplies.

The solubility of radium in water is highly variable. A suitable leachability test for radionuclides ASTM Standard Test Method, D4319-93 is used for radionuclides. The leachability factor, $k_d$, varies by a factor of 12 – 950,000 dependent on the soil types (IAEA, 2010, pp 33-36). This leachability property is a naturally occurring phenomenon. The radioactive component of any dust deposited is expected to have a negligible impact on existing soluble radioactive component and is unlikely to be identifiable from any natural occurring variability.

Consumption of the insoluble component settled at the base of the tank is considered unlikely. Any household water filtration system would remove any insoluble fraction should it resuspend in the tank. Irrespective of any filtration applied, consumption of insoluble dust has been considered as an exposure pathway in relation to dust settled on local vegetables (RAR, Section 9.2.3). The dose was deemed as negligible.

Recommendations have been made to Kalbar (Section 8 of this Statement) to expand baseline monitoring to identify existing concentrations of Ra-226/228 concentrations in tank water supplies of local receptors, any other concerned parties, in addition to the alpha/beta radioactivity screening that has occurred to date (Coffey, HHA). Assessment should also include any tank sediment currently present. It is important current levels and are fully understood.

Assessment of tank water supplies will be in integral component of the Kalbar radiation monitoring programme outlined in the Radiation Management Plan.

## DUST IMPACT ON CONSUMPTION OF LOCALLY GROWN VEGETABLES

There were some submissions commenting on the impact of dust on vegetable crops grown locally. Responses have been limited to the radiological health impacts from the consumption and handling of vegetable and crops.

Some comments were as follows:

***Submission 058***
*A large percent of Victoria's leafy greens are grown in this area and even if it is washed before consumption it can still absorb contaminates during growth and endangering people handling it during harvest.*

DB Response. The principal plant uptake process for radionuclides is via the root system, which were assessed (RAR, Section 9.2.3). Farmer doses have also been assessed. (see additional response below).

**Submission 202**
*How are they going to make sure the Vegetable farmers won't be affected with contamination of their Vegies? The wind is always very strong in the proposed mining area and dust from the Mine will travel a very long way.*

**Submission 344**
*Will we have the confidence to be outside when the wind is blowing and that the residue of the mining will not be in the air? Will we have the confidence to eat the local produce from the Lindenow Flats? That is not including our own produce from our veggie plots. Will our fresh water in our own tanks be contaminated by radioactive substances in the air?*

**Submission 837**
*P17 - Ingestion of dust from crops grown on the nearby Mitchell River.*

**Submission 054**
- *Contaminating vegetable crops,*
- *People complaining about gritty lettuce or cabbage then finding on Facebook they might be contaminated with Ilmenite*

*The EES fails to map or define the distances that the dust will travel under different wind speeds. It is foreseeable that farms, school, homes, businesses and water supply will be contaminated by radioactive dust.*

DB Response: Radiation dose impacts have assumed extreme worst-case assumptions in its estimate (see below) which will translate to any community member living outside the project area.

**Submission 734**
*The potential of fresh food contamination from wind-blown dust over this well established commercial vegetable growing area is unacceptable. Wind-blown radioactive dusts suggest the*

*disastrous outcome that lies before local vegetable growers and their many years of farm development.*

**Submission 813**
*Effects of dust on the health of farm workers: There was no mention of the impact of dust on workers in the field, particularly silica dust which is known to cause lung disease plus other carcinogenic substances that could impact on human health (refer to chapters on radiation..*

**Submission 829**
*Toxic dust blowing from the mine site will put our whole industry at risk not to mention our export crops…*

DB Response:
Dose intake pathways for vegetable uptake from local grown produced have been included in the RAR, Section 9.2.3. Multiple exposure pathways were considered

Scenario (1) considered the consumption of vegetables grown in soil contaminated from dust originating from the project. Conservative assumptions included:

- A dust deposition of 0.2 g/m$^2$.month for 12 months;
- The entire dust deposited is ore (1 Bq/g) and not overburden or topsoils;
- Dust deposition occurs for 20 years at these concentrations;
- An individual's total annual vegetable consumption was grown in the considered soils; and
- None of the vegetable are protected from dust.

Based on these assumptions, the estimated dose was 0.006 mSv (or 1%) greater than the dose that would be otherwise received from consumption of unaffected crops (RAR, 9.2.3). This impact is considered of inconsequential statistical significance.

Scenario 2 considered the consumption of dust through ingestion (swallowing) of dust that had deposited directly onto crops. A situation considered was a farmer handling potentially contaminated crops daily for 12 months and ingesting the dust they had handled. The resulting dose was <0.002 mSv and considered inconsequential dose pathway. For a consumer of a dust-contaminated crops, the dose will be considerably lower as daily dust consumption, at these concentrations, for 12 months is unlikely to occur.

**Washing of vegetables** - Some comments have related directly to remarks in the in the RAR that vegetables would be pre-washed prior to consumption.

**Submission 218**
*We grow beetroot, leek, beans, broccoli, cabbage and celery, with the latter four lines considered safe to be eaten raw under the Freshcare Standard. It would be negligent to assume that any toxic, radioactive and carcinogenic dust would miraculously disappear from a cabbage or head of broccoli that, at best might get a quick rinse before being consumed.*

**Submission 763**
*The EES radiation study found the dust containing radioactive materials contaminating vegetable crops to be possible, yet the consumption of vegetables contaminated with air born radioactive dust was dismissed as a potential pathway and not considered further as a part of this EES, as it was incorrectly claimed that people always wash their vegetables. This is a fundamental failing of the EES process and needs to be examined as a matter of urgency.*

**Submission 813**
*In regards to the Horticulture assessment…*
*RMCG relied on produce either being washed or irrigated. Not all the produce is washed nor is it irrigated a few weeks before harvest resulting in a long period of time for dust to gather on the crops. Therefore, the risk from contaminated dust is high.*

**Submission 837**

*P40 – Radionuclides in Vegetables and Crops.*
*While the studies conclude that washing vegetables at the farm and again prior to consumptions reduces the potential for uptake of radionuclides it does not state that it will eliminate them. Nor does it take into consideration the handling by farm workers in picking and packing these items and their exposure. Nor does it consider that not all vegetables are washed prior to packing and shipping*

DB Response:
Several submissions commented that washing of some vegetables was not possible or viable (e.g. cauliflowers), a fact that I acknowledge since drafting of the RAR.

However, Scenario 2 above assumes the worst-case consumption of only unwashed vegetables, daily for a 12-month period. This would result in an inconsequential dose.

The RAR never intended to suggest that washing of vegetable be a measure to limit or eliminate the radiation exposure. Rather, it is intended to highlight that if vegetables were washed, it will further reduce an already inconsequential dose.

**Cattle consumption** - Two submission raised concerns about the community consuming meat or other produce from stock that was consuming the vegetables.

**Submission 202**
*Also, there's radiation to consider in the dust too! The dust with blow onto farm land, their stock eat the grass and then ingest contaminated dust. Humans eat meat so we then we consume what cows have been exposed to.*

**Submission 781**
*Airborne contaminated dust also poses a significant risk as the stock inhale and ingest it. It is also known that silica, monazite, thorium and vanadium are present in these sands at high levels, all of which are toxic to humans and animals.*
Animals

DB Response:

Human consumption of grazing farm animals and related produce, was seen as an inconsequential exposure pathway relative to other pathways assessed. This decision was based on the low radioactive content of the dust, and the estimated doses to a member of the public as result of crop consumption directly.

Internationally recognised literature (IAEA 2010, Part 6) discusses the transfer of radionuclides to livestock in the natural environment. It is recognised the ingestion of contaminated feed is the major pathway for livestock, and that the ingestion of contaminated feed, and the absorption and retention of that feed, that will determine radionuclide content in animals. Absorption values differ

only slightly for ruminants (cattle) in comparison with monogastric animals (pigs, hens, and humans). Transfer to tissue and milk products will be largely dependent on an animal's diet including feeding strategies, agricultural practices, and local seasonal conditions.

Whilst this exposure pathway is considered to be negligible, the impact can be modelled using commercially available software that is available. Data on local farming practices can be used as inputs where it is applicable.

I recommend that an assessment of this exposure pathway be undertaken for incorporation into the Radiation Environment Plan (refer to section 6.5.3 above). The REP requires approval from the Victorian DHHS prior to issue of a Management Licence.

There were some public submissions with concerns of radionuclides leaching from the tailings storage facility.

**Fine Sand Tailings** - Two submission suggested the what was deposited would have a higher radioactive concentration than what was removed:

**Submission 408**
*Statements to the effect that the tailings seepage in the shallow Coonqulmerang formation (the 90m deep sand formation from with the mine is proposed to extract minerals) from underneath the extracted void will have a mineral concentration lower than existing levels. It is difficult to see how there would not be an increased concentration of minerals given that the sand washing processes used generates the waste water likely to form seepage. Clarification of the justification for that statement are required.*

**Submission 813**
*Low levels of radioactive isotopes can become concentrated in mine tailings. Radionuclides become airborne and will disperse in dust from the stockpiles of overburden.*

DB Response:
It is not possible for tailings to be more concentrated than what was initially removed from the mine void. The undersized ore (0.8 Bq/g) (RAR, Table 11) will be blended with overburden. The overburden radioactivity is comparable to garden soils (0.025 Bq/g) (EES, Appendix A002, Table 7).

**Leaching** – Some submissions were concerned on radioactive materials leaching from the TSF:

**Submission 763**
*It is essential to ensure mineral sands mines are properly rehabilitated as they are progressively decommissioned after the depletion of ore bodies, or abandoned following low world commodity prices. As there is a particular concern that thorium, the principal radioactive component of monazite, may over time leach from tailings dumps into local water supply systems.*

**Submission 766**
*Seepage from tailings dams will get into the groundwater. A lot of these chemicals and elements will end up in the Mitchell River, and from there into the Gippsland Lakes. They will include a mix of heavy metals, radionuclides, processing chemicals and debris from the mine site.*

**Submission 813**
*Leakage, over topping and releases from the tailings dam can contaminate water sources and soil, accumulating radionuclides in plants and the soil. They then become part of the food chain affecting the entire ecosystem.*

**Submission 813**
*The proponent was expected to discuss the technical feasibility and environmental implications of tailings management and to identify the composition of tailings and waste material, including radiological content and activity levels. They were also expected to describe methods and strategies to demonstrate the radioactivity of tailings and waste materials stays within environmentally acceptable exposure levels.*

DB Response:

It is important to recognise that based on the low radioactive concentration of the Fine Tails being returned to the TSF and the mine void (<1 Bq/g), the material is not recognised as a radioactive source in Victoria, and would otherwise be exempt from further consideration. (Similar exemptions would apply in States across Australia and internationally). As a stand-alone operation the waste is considered 'non-radioactive', warranting no radiation regulation. However, as the HMC product will exceed 1 Bq/g, the overall mining and processing operations must be considered.

Irrespective of regulatory implications, the radionuclide concentrations in the Fine Tailings returned to the mine void (0.5 Bq/g) will be lower than that of the originally mined Ore (0.8 Bq/g). The Fingerboard primary mineral separation process is a purely mechanical and gravimetric process, with no crushing, chemical or thermal alteration of the mineral. Subsequently the potential for migration of radioactivity from the mineral into the local water table in the area would be identical to the existing situation that occurs naturally with the presence of the heavy mineral ore deposits. The existing orebody is already naturally heavily saturated from the local water table.

Radioactivity is already present naturally in ground water supplies in the region and has been identified in the local water table and the Boisdale aquifer located 15 km from the Project area (refer 9.2.7 of RAR for the full details).