TETRA TECH COFFEY

Level 1, 436 Johnston Street
Abbotsford
Vic 3067 Australia

[redacted]
tetratechcoffey.com

11 June 2021

Our ref: 754-ENAUABTF11607AK_L01_HHRA

Kalbar Operations Pty Ltd
c/o White & Case Lawyers
Via Email

Dear Ms Campbell,

Response to the IAC's information requests (26 May 2021, Tabled Document 401), requests 11 to 13 (human health)

Questions and responses

11. In Tabled Document 302 (Technical Note 19) could the Proponent please provide the source of the Particle Deposition Rates in Column 3 of the Table on pdf Page 19 and particularly that of Uranium of 3.8 ug/m2/day.

The particulate deposition rates set out in Table 9 of technical note TN 019 (Tabled Document 302, pdf page 19) were estimated using Equation 4, as presented in Table 4 of TN 019. On checking Equation 4 in response to this question, it was noted that the input parameter for the vertical deposition rate (DR) set out in Table 5 was presented as '0.05' where it should have been '0.02'. This parameter has corrected and the relevant reference in the report is set out in Appendix 1.

The correction to the vertical deposition rate set out in Table 5 of Appendix 1 does not change the calculated particle deposition rates set out in Table 9 or any of the other calculations or risk outcomes set out in the report.

Note that Appendix 1 is in the same form as the version of the report attached to TN 019 (Tabled Document 302), except for the correction described above and the change made to the way information is presented in Attachment A to the report, which was made in response to question 13 below.

12. Ms Teague responded to the issues in Tabled Document 317 verbally in the Hearing and a written response was promised; could this please be provided.

Tabled Document 317 is an email from Mr Helps, which references the ATSDR Substance Priority List as a source of screening criteria with which to compare measured concentrations of contaminants in air and water.

ATSDR is the US Agency for Toxic Substances and Disease Registry. The ATSDR Substance Priority List is not a list of "most toxic" substances, but rather a prioritization of substances based on a combination of their frequency, toxicity, and potential for human exposure at sites on the National Priorities List (**NPL**). It is used to identify which substances will be candidates for detailed toxicological profiles compiled by the ATSDR, which include the selection of appropriate toxicity criteria for Minimal Risk Levels (**MRLs**). MRLs are generally based on the most sensitive substance-induced end point considered to be of relevance to humans. Details on the methodology used to rank substances on the ATSDR Substance Priority List can be found in the Support Document to the 2019 Substance Priority List. This should be read to understand how the values derived for substances are calculated to determine the ranking of a substance on the list based on points relating to how often it is detected at sites on the NPL, its toxicity score, and the potential of human exposure.

The Geometric Mean of Maximum Concentrations (**GMMC**) cited by Mr Helps in Tabled Document 317, represents the geometric mean of the maximum concentrations measured in air, soil or water across the NPL sites. The calculation of a Theoretical Daily Dose (**TDD**) is estimated based on standard default exposure parameters which are then multiplied by the GMMC, thus providing the theoretical daily intake of a contaminant if a person were exposed to the substance in all impacted media across the NPL sites. This is not the methodology for estimating chronic exposures which require appropriate toxicity criteria for each exposure route, or for deriving screening levels. Mr Helps appears to be using GMMC and TDD as screening levels, which is an inappropriate use of these numbers .

The ATSDR Substance Priority list is not referenced as a source of toxicity information in the *National Environment Protection (Assessment of Contaminated Sites) Measure 1999,* as amended in 2013 (**ASC NEPM**) (refer to Schedule B4, section 5.1.1) because it does not contain specific toxicity information nor does it provide toxicity criteria or derive screening levels. While the ASC NEPM does include the ATSDR MRLs and toxicological reviews as a reliable source of information, the ATSDR has not derived MRLs for Titanium or Bismuth. Likewise, the Handbook of the toxicology of metals (Nordberg, 2007) is not considered to be a reliable source of toxicity information by the ASC NEPM.

13. In Tabled Document 302 (Technical Note 19) pages 27 to 31 authored by Coffey use Scientific notation (e.g Arsenic at 4.9E+01 which translates to 49 ug/kg). 49 ug/kg of Arsenic is 688.879 times the ATSDR Theoretical daily dose of 0.07113 mg/day. Can the Proponent please provide this same report in normal notation please.

As explained above, it is considered inappropriate to use the ATSDR Theoretical Daily Dose in an assessment of health risk, as this is not consistent with the ASC NEPM methodology.

The report that was included in TN 019 (Tabled Document 302) has been amended to present the numbers shown in Attachment A in numeral notation rather than scientific notation. A copy of the updated report is set out in Appendix 1.

[redacted]

Regards,

Karen Teague
Principal - Risk Assessment

Attachment: Appendix 1 – Updated TN 019 (Tabled Document 302)

APPENDIX 1

Updated TN 019 (Tabled Document 302)

coffey
A TETRA TECH COMPANY

Level 1, 436 Johnston Street
Abbotsford
Vic 3067 Australia
[redacted]
coffey.com

Technical Note

Author	Karen Teague	**Technical Note date**	28 May 2021
Project reference	Fingerboards Mineral Sands Project		
Subject:	Evaluation of potential exposures to sensitive receptors associated with dust particulates and fallout.		

1. Introduction

This technical note presents an evaluation of potential exposures to sensitive receptors associated with dust particulates and dust fallout, and was prepared to address a number of related concerns raised in public submissions to the Inquiry and Advisory Committee for the Fingerboards Mineral Sands Project ("the project"). The substances of concern are metals (selected for modelling by Katestone) that have been predicted to be present in airborne dust and assumed to be subsequently deposited on soil, crops or feed.

Regional receptor populations of interest were generally identified within a 5 km radius beyond the project area boundary in the Human Health Risk Assessment report (Coffey, 2020), based on the air quality report (Katestone, 2020) and the presence of waterways and groundwater that may flow from the project area. The Katestone report identified the sensitive receptor settings, all generally within a 3 km radius of the project area boundary or in the project area near the project boundary, as being the receptors likely to be exposed to higher levels of dust and dust fallout.

The prevailing wind direction is from the southwest. Horticultural farms are located in the Lindenow Valley to the northeast of the project area, and within a 5 km distance of the project area boundary. Beef and dairy cattle farms are located adjacent to the project area and, in some instances, within the project area near the project boundary.

The sensitive receptors selected for evaluation in this technical note were rural residential populations that include young children. Young children are considered to be the most sensitive population group in the exposure scenarios assessed due to their behaviours and physiology (enHealth, 2012a). The exposure parameters used to assess receptors in a residential setting are also considered to be protective of children in a child-care, kindergarten or school setting. Adult agricultural workers in the regional area have also been selected.

The locations of the sensitive receptors, which are predominantly residential receptors (including those in agricultural settings), are presented in Figure 1.

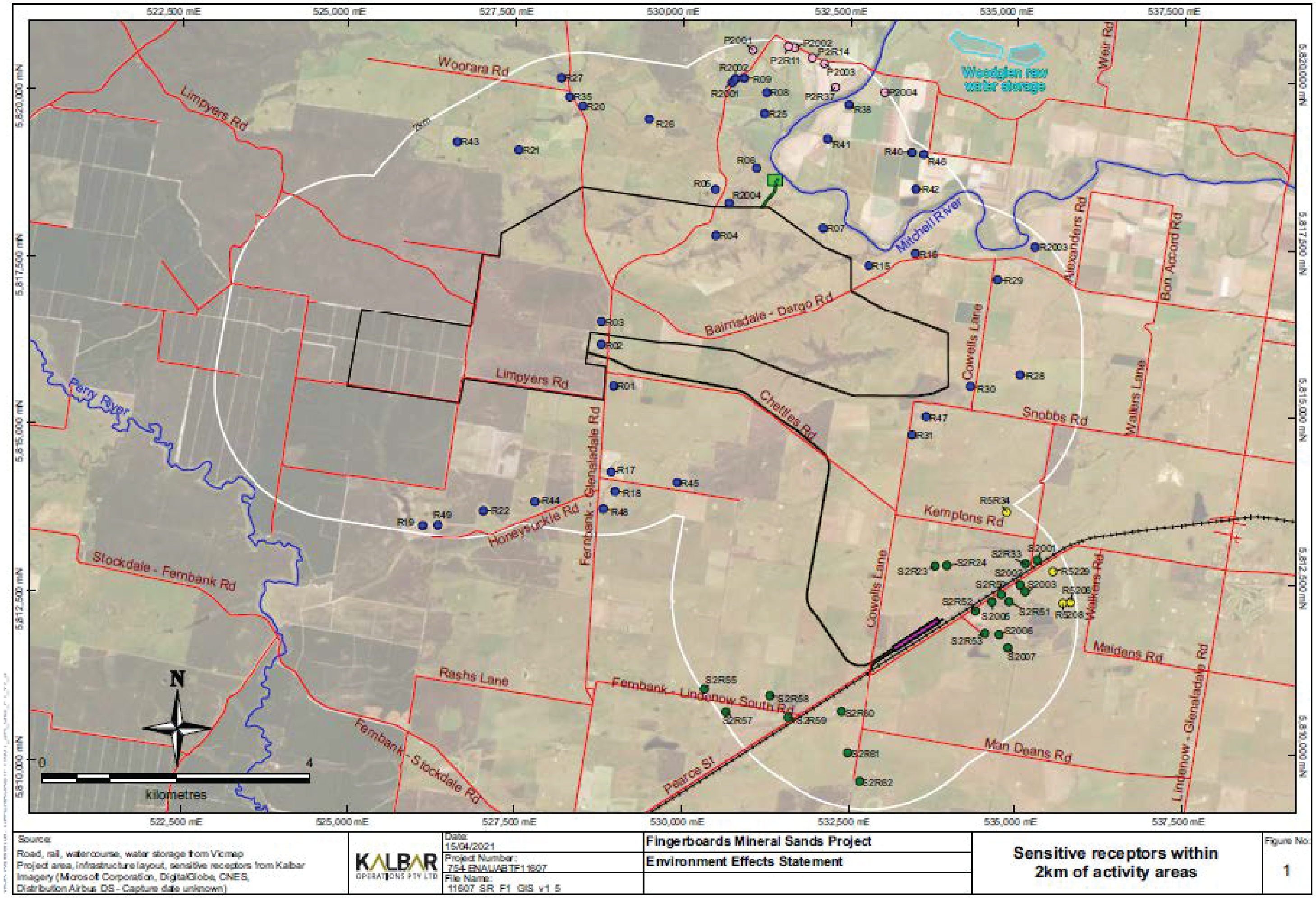

Figure 1: Sensitive receptor locations in the vicinity of the project

2. Objective

The purpose of this technical note is to evaluate potential exposures to identified metal/metalloid contaminants in particulates that have been predicted to migrate to sensitive receptors of concern as a result of project activities. The migration pathways of concern in this evaluation include contaminants in airborne particulates and dust fallout. Specific objectives of the technical note include:

- Estimation of contaminant concentrations in dust deposited on crops, feed and soil based on ambient air modelling undertaken by Katestone (2020, 2021), uptake modelling in edible plants and intake modelling for cattle with subsequent transfer to milk and meat.
- Exposure modelling to estimate and characterise the potential health risks to sensitive receptors who consume local crop produce, and/or animal products associated with beef cattle and dairy cattle.

This technical note does not address exposures associated with radionuclide activity, gases or particulate matter as $PM_{2.5}$ or PM_{10}.

3. Health risk assessment methodology

The health risk assessment approach adopted in this evaluation was generally conducted in accordance with the following Australian guidance:

- National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013' (NEPC, 2013). The provisions within the NEPM are:
  - Guideline on Site-Specific Health Risk Assessment Methodology, Schedule B4.
  - Guideline on Derivation Health-Based Investigation Levels Schedule B7.
- Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards' (enHealth, 2012b).

Additional national and international resources have been referenced where information or specific methodology was not available in the NEPM 2013 including the following sources:

- Air Toxics Hot Spots Program Risk Assessment Guidelines (2015) and the Technical Support Document for Exposure Assessment and Stochastic Analysis (2012). Office of Environmental Health Hazard Assessment. California Environmental Protection Agency.
- Risk Assessment Guidance for Superfund. Vol 1. Human Health Evaluation Manual (Part A). Interim final. EPA/540/1-89/002. Washington. US Environmental Protection Agency. Office of Emergency and Remedial Response.
- International Agency for Research on Cancer (IARC).
- Integrated Risk Information System (IRIS), U.S. Environmental Protection Agency (USEPA).
- The Agency for Toxic Substances and Disease Registry (ATSDR).
- Australian Drinking Water Guidelines (NHMRC, 2011)
- Risk Assessment Information System (RAIS, 2021).
- Australian Exposure Factors Guide. (enHealth, 2012b).
- Food Standards Australia New Zealand (FSANZ).

3.1. Risk assessment methodology

The risk assessment methodology adopted in this technical note is summarise below. More detail on the environmental setting and conceptual site model can be found in the Human Health Risk Assessment (Coffey, 2020).

- Identification of chemicals of potential concern (COPC)
- Toxicity Assessment: The dose-response assessment of contaminant toxicity is evaluated for each COPC and the adopted toxicity criteria and related inputs are presented for each pathway.
- Exposure evaluation: Summarises the data available based on the predictive modelling undertaken in the air quality report (Katestone, 2020, 2021) and the concentrations selected for further evaluation. Presents the equations and inputs used to estimate the concentrations for each COPC at the point of exposure for each media. Presents the exposure equations and assumptions for each receptor population.
- Risk Characterisation: Calculates the health risk estimates relating to each exposure pathway and COPC and presents the outcomes of the risk evaluation.
- Uncertainty Assessment and Data Gap: Details the key uncertainties at each stage of the risk evaluation.
- Conclusion: Discussion of predicted risks to human receptors.

4. Chemicals of potential concern

The chemicals of potential concern (COPC) selected for this evaluation were the compounds detected and modelled in dust as reported in the Stage Two Air Quality and Greenhouse Gas Assessment for the Fingerboards Mineral Sands Project report prepared by Katestone (2020) and additional modelling presented in Katestone (2021).

The focus of this Technical Note is on the metals and metalloids in particulate matter. The evaluation of radiation activity has not been undertaken in this note as it has been evaluated separately elsewhere.

The COPCs considered in Katestone's modelling reports include: Arsenic, Bismuth, Cadmium, Cerium, Cobalt, Chromium, Copper, Lanthanum, Lead, Manganese, Nickel, Selenium, Tin, Thorium, Titanium, Uranium, Vanadium, Tungsten, Zinc, Zinc Oxide and Zirconium. Whilst most of these COPCs were evaluated for exposures to sensitive receptors, Titanium and Bismuth were not quantitatively assessed due to the lack of sufficient toxicity data.

5. Toxicity evaluation

Toxicity assessment provides an evaluation of the inherent toxicity of chemicals associated, in this instance, with site contamination. It is a process of determining whether human exposure to a chemical could cause an increase in the incidence of an adverse health condition, either cancerous or non-cancerous in nature. It considers:

- the nature of adverse effects related to the exposure;
- the dose-response relationships;
- the weight of evidence for effects such as carcinogenicity; and
- the relevance of animal data to humans.

The results of the toxicity assessment are an appreciation of the toxicity of the COPC and a set of chemical-specific toxicity criteria that are used in the assessment of health risks from COPC exposures.

Classification of carcinogenicity

COPCs are assessed differently based on the type of health effect. The two classes based on dose-response characteristics are:

- non-threshold effects; and
- threshold effects.

Where a threshold refers to a dose below which deleterious effects are not expected to occur. This is considered to result from biological mechanisms that have the ability to metabolise or excrete a toxin or repair damage up to a certain dose (enHealth, 2012a). Where a chemical exhibits a non-threshold (i.e. carcinogenic) health effect based on genotoxicity, the assessment is based on an incremental lifetime risk of cancer.

A review of the International Agency for Research on Cancer and U.S. Environmental Protection Agency cancer classifications for the identified COPCs was conducted. The IARC and USEPA cancer classifications are summarised in Table 1 The dose-response comments indicate which approach was adopted for each COPC.

Table 1: Carcinogenic classification and adopted dose-response.

Chemical	Classification of Carcinogenicity		Comments
	IARC (1)	USEPA (2)	
Arsenic	Group 1	Class A	Arsenic is a known human carcinogen, based on human epidemiological studies that show skin and internal cancers (in particular, bladder, liver and lung) associated with chronic exposures to arsenic in drinking water. Note: carcinogenic assessments undertaken on other chemicals are primarily based on animal studies however the lack of animal studies on arsenic is because arsenic has not been shown to cause cancer in rodents (the most common species used in animal tests), due to interspecies differences between rodents and humans. Arsenic has been evaluated using a threshold approach based on the ASC NEPM (2013) review which noted the evidence points to weak or non-existent genotoxicity, in addition to their consideration of a number of other uncertainties.
Bismuth	Unclassified	Unclassified	Toxicity criteria not established by international agencies, likely due to its relative insolubility in water and limited/lack of epidemiology or animal toxicity studies. Bismuth has not been evaluated further.
Cadmium	Group 1	Unclassified	The ASC NEPM review of cadmium noted the inhalation of cadmium has been associated with carcinogenic and non-carcinogenic effects. While cadmium is thought to be potentially genotoxic, the weight of evidence is not clear. In addition, epidemiology studies associated with lung cancer have confounding issues that limit useful interpretation. On the basis there is no evidence of carcinogenicity via the oral route of exposure and the uncertainties associated with the inhalation studies, the NEPM adopted a threshold approach for oral and inhalation pathways.
Cerium	Unclassified	Unclassified	The 2009 review by IRIS found no information available on the carcinogenicity of cerium oxide and cerium compounds in humans. A threshold approach was adopted for the evaluation of cerium.

Chemical	Classification of Carcinogenicity		Comments
	IARC [(1)]	USEPA [(2)]	
Chromium	Group 3	Class D	Based on Chromium III which was identified as the dominant form based on geochemical studies (Kalbar, 2020). The IARC classification is based on Cr VI. The review of international guidance by ASC NEPM noted there is limited data available regarding the carcinogenic potential of ingested Cr (VI) (considered to be more toxic than Cr (III), and along with other considerations determined a threshold approach should be adopted.
Cobalt	Group 2B	Unclassified	The ASC NEPM noted while data is limited, based on the weight of evidence, cobalt is not (or is only weakly) genotoxic; it was recommended that a threshold approach be adopted
Copper	Unclassified	Class D	The ASC NEPM adopted a threshold approach for the evaluation of copper.
Lanthanum	Unclassified	Unclassified	The available toxicity data is based on threshold health end points.
Lead	Group 2B	Class B2	The ASC NEPM review noted whilst some evidence of carcinogenic effects has been associated with exposure to lead (in experimental animals, with inadequate evidence in humans), there is evidence from human studies that adverse effects other than cancer may occur at lower lead levels and would also be adequately protective of carcinogenic effects.
Manganese	Unclassified	Class D	The ASC NEPM adopted a threshold approach for the evaluation of manganese.
Nickel	Group 1, 2B	Class A	The IARC classification is based on nickel compounds and metallic nickel respectively, and the USEPA classification is based on workers exposures to nickel refinery dust. On the basis the ASC NEPM review noted there was no substantial evidence that nickel compounds may produce cancers other than in the lung or nose in occupationally exposed persons, and limited animal studies on carcinogenic effects after oral exposures to nickel compounds did not show any significant increase in tumours, a threshold approach was adopted for the evaluation of both oral and inhalation pathways.
Selenium	Group 3	Class D	The ASC NEPM adopted a threshold approach for the evaluation of selenium.
Thorium	Group 1	Unclassified	Classification of carcinogenicity based on radiation activity which is not evaluated in this technical note. The 2019 review undertaken by the ATSDR found very limited data on health effects due to exposures to thorium in humans or animals and hence uncertainties on whether the adverse health effects associated with exposure to thorium are the result of the ionizing radiation, the chemical toxicity of thorium, or a combination of radiation and chemical toxicity. The small number of epidemiology studies have primarily focused on the potential increases in the risk of cancer deaths in workers exposed to airborne thorium and its progeny radionuclides. Inhalation, oral, and dermal studies in laboratory animals have identified several potential targets of toxicity however, most studies did not find adverse effects. Toxicity criteria not established by international agencies, likely due to limited/lack of epidemiology or animal toxicity studies. Thorium has therefore not been evaluated further.

Chemical	Classification of Carcinogenicity		Comments
	IARC [1]	USEPA [2]	
Tin	Unclassified	Unclassified	Based on the 2005 review by the ATSDR, the available studies in humans indicates there is no evidence that chronic exposures to inorganic tin affects human health. A relatively limited number of studies in animals have not clearly established potential target organs for inorganic tin toxicity.
Titanium	Group 2B	Unclassified	The IARC classification is based on titanium dioxide. Toxicity criteria for titanium has not been established by international agencies and although recent implant studies indicate toxicity associated with rare occurrence of allergic reactions, titanium is considered to have low toxicity. Titanium has therefore not been evaluated further.
Tungsten	Unclassified	Unclassified	The available toxicity data is based on threshold health end points.
Uranium	Unclassified	Unclassified	Although not classified on carcinogenicity, the effects of radiation activity related to uranium is not evaluated in this technical note. On this basis a threshold approach was adopted to evaluated non-carcinogenic health effects.
Vanadium	Unclassified	Unclassified	The available toxicity data is based on threshold health end points.
Zinc	Unclassified	Class D	The ASC NEPM adopted a threshold approach for the evaluation of zinc.
Zinc Oxide	Unclassified	Unclassified	Evaluated as zinc using a threshold approach.
Zirconium	Unclassified	Unclassified	The available toxicity data is based on threshold health end points.

1 *IARC Cancer Classification: Group 1 (carcinogenic to humans), Group 2A (probably carcinogenic to humans), Group 2B (possibly carcinogenic to humans), Group 3 (unclassifiable as to carcinogenicity in humans).*

2 *USEPA Cancer Classification:*

- *1986 Guidelines: Group A (carcinogenic to humans); Group B1 (probable carcinogenic to humans, limited human evidence); Group B2 (probable carcinogenic to humans, sufficient evidence in animals); Group C (possibly carcinogenic to humans); Group D (unclassifiable as to carcinogenicity in humans).*
- *2005 Guidelines: CH (carcinogenic to humans); LH (likely to be carcinogenic); SE (suggestive evidence of carcinogenic potential); InI (inadequate information to assess carcinogenic potential); NH (not likely to be carcinogenic)*

Dose response assessment

The toxicity reference value (TRV) is the adopted threshold or non-threshold toxicity value for each COPC. In this assessment, TRVs reviewed and selected in the NEPM 2013 have been adopted where available.

Exposure to the selected COPCs in this assessment may also occur from other sources and are considered to be background exposures. The background contribution is considered in the dose-response characterisation to identify what increases in intake, from environmental COPC sources, may cause adverse health effects.

The adopted TRVs and pathway specific adjustments are presented in Table 2as selected in the ASC NEPM 2013. Where TRVs have not been established in the ASC NEPM, appropriate TRVs were sourced from other international agencies.

Table 2: Adopted chronic oral and inhalation toxicity reference values, background intakes and bioavailability

COPC - Threshold Health Effects	Toxicity Reference Value Oral (TRVo) (mg/kg/ day)	Reference	Oral Bioavailability Bo (%)	Background Intake Oral (BIo) (% of TDI)	Toxicity Reference Value Inhalation (TRVi) (mg/m3)	Reference	Background Intake Inhalation (BIi) (% of TC)
Arsenic	0.002	ASC NEPM	100	0.5	0.001	ASC NEPM	0
Bismuth	Toxicity criteria not established by international agencies, likely due to its relative insolubility in water and limited/lack of epidemiology or animal toxicity studies. Bismuth has not been evaluated further.						
Cadmium	0.0008	ASC NEPM	100	0.6	0.000005	ASC NEPM	0.2
Cerium	NE	-	NE	NE	0.0009	USEPA (IRIS)	0
Chromium (1)	1.5	USEPA (IRIS), (Cr III)	100	0.1	0.0001	ATSDR (Cr III)	0
Cobalt	0.001	ASC NEPM	100	0.2	0.0001	ASC NEPM	0
Copper	0.14	ASC NEPM	100	0.7	0.49	NE (2)	0.7
Lanthanum	0.00005	USEPA (PPTRV)	10 (3)	0	0.21	NE (2)	
Lead (4)	0.0035	NHMRC 2011	100	0.35	0.01	NE (2)	0.35
Manganese	0.16	ASC NEPM	100	0.5	0.00015	ASC NEPM	0.2
Nickel	0.012	ASC NEPM	100	0.6	0.00002	ASC NEPM	0.2
Selenium	0.006	ASC NEPM	100	0.6	0.02	ASC NEPM (2)	0.6
Thorium	Toxicity criteria not established by international agencies, likely due to limited/lack of epidemiology or animal toxicity studies. Thorium has therefore not been evaluated further.						
Tin	0.6	USEPA (HEAST)	100	0.1	0.3	ATSDR	0.1
Titanium	Toxicity criteria for titanium has not been established by international agencies, although recent implant studies indicate toxicity associated with rare occurrence of allergic reactions. Titanium has therefore not been evaluated further.						
Tungsten	0.008	USEPA (PPTRV)	50 (3)	0	0.0028	NE (2)	0
Uranium	0.002	ATSDR, 2013	10 (3)	0	0.00004	ATSDR, 2013	0
Vanadium	0.005	RAIS. Surrogate (5)	100	0	0.0007	USEPA (PPTRV)	
Zinc & zinc oxide	0.5	ASC NEPM	100	0.8	1.75	ASC NEPM. (2)	0.8
Zirconium	0.00008	USEPA (SCREEN)	10 (3)	0	0.00028	NE (2)	0

NE – Not established

1 Chromium analysis of ore and overburden indicates the measured chromium consists primarily of Cr III (Kalbar, 2020). Where Cr III toxicity related information is available it has been adopted.

2 Extrapolated based on oral TRV

3 Based on the derivation of the TRV is based on soluble compounds, as well as the adopted transfer factors, however the low solubility of natural forms of the element in ore in water indicating the bioaccessibility would be significantly lower: Lanthanum (NHMRC (2011), PPTRV (2018)), Tungsten (ATSDR (2005), USEPA (2015)), Uranium (ATSDR (2013)) and Zirconium (PPTRV (2012), UKPID (1997)).

4 Blood lead modelling was not undertaken for in this evaluation, noting this is not consistent with the ASC NEPM methodology. Due to the complexity of the calculations required to estimate COPC concentrations in various media, the ingestion TRV adopted in the Australian Drinking Water Guidelines (NHMRC,2011, updated March 2021) was used in this evaluation.

5 Based on Vanadium Pentoxide. Molecular weight contribution adjustment.

IRIS: Integrated Risk Information System
PPRTVs: Provisional Peer-Reviewed Toxicity Values
HEAST: Health Effects Assessment Summary Tables
ATSDR: The Agency for Toxic Substances and Disease Registry
RAIS: Risk Assessment Information System
SCREEN: Based on studies with lower reliability or lower confidence.
ASC NEPM 2013, Schedule B7 Appendix A.

6. Exposure Assessment

Chemical substances in dust fallout off-site have the potential to be ingested either directly through incidental consumption of soil or indirectly via food grown or raised in fallout areas that is subsequently consumed.

The exposure pathways quantitatively assessed are:

- Consumption of beef and milk from livestock raised in the regional area, that may have ingested impacted pasture, soil or inhaled particulates associated with Project activities.
- The deposition of dust on crops and soil associated with dust fallout and subsequent ingestion of crops and incidental ingestion of soil by sensitive receptor populations.
- Inhalation of contaminants in airborne particulates.
- Incidental ingestion of COPC impacted soil as a result of dust deposition.

The assessment of potential inhalation of COPCs in airborne particulates and the ingestion of chemicals of concern in dust, generated from project activities that is deposited on the ground, has been undertaken based on the approach presented by enHealth (2012) and the USEPA (1989).

6.1. Modelled ground level concentrations

The locations of sensitive receptors, predominantly residential, are presented in Figure 1. The area where higher COPC concentrations were modelled were generally at sensitive receptors located to the northeast of the project area.

The maximum concentrations of COPCs predicted at ground level at sensitive receptor population locations, as identified in the air quality assessment (Katestone 2020), are presented in Table 3.

Table 3: Modelled concentrations at sensitive receptors [µg/m^3]

Chemical	Maximum concentration adopted	Maximum predicted concentration at identified receptors due to Project activities in Year 5, Year 8 and Year 12 of the mine operations (1,2)			Maximum concentration at receptor R2004 due to Project (1,3)
		Year 5	Year 8	Year 12	Year 12
	[µg/m^3]	[µg/m^3]			
Arsenic	**0.0019**	0.0017	0.0016	0.0019	0.0014
Bismuth	**1.2E-05**	NA	NA	NA	1.2E-05
Cadmium	**0.00022**	0.00022	0.00022	0.0002	0.00022
Cerium	**0.0012**	NA	NA	NA	0.0012
Chromium	**0.0052**	0.0049	0.0048	0.0052	0.0045
Cobalt	**0.0013**	0.0012	0.0012	0.0013	0.0012
Copper	**0.0018**	0.0012	0.0012	0.0013	0.0018
Lanthanum	**0.00058**	NA	NA	NA	0.00058
Lead	**0.0026**	0.0026	0.0026	0.0026	0.0025
Manganese	**0.0055**	0.0045	0.0038	0.0055	0.0038
Nickel	**0.0017**	0.0015	0.0015	0.0017	0.0014
Selenium	**0.0022**	0.0022	0.0022	0.0022	0.0022
Thorium	**0.0048**	0.004	0.004	0.0048	0.0012
Tin	**0.0047**	0.0047	0.0047	0.0047	0.0047
Titanium	**0.13**	0.097	0.086	0.13	0.064
Tungsten	**0.0061**	0.0061	0.0061	0.0061	0.0061
Uranium	**0.0022**	0.0022	0.0021	0.0022	0.0021
Vanadium	**0.003**	0.0025	0.0023	0.003	0.0019
Zinc	**0.061**	0.061	0.06	0.061	0.06
Zinc Oxide	**0.23**	0.17	0.17	0.17	0.23
Zirconium	**0.0046**	0.0036	0.0033	0.0046	0.0017

NA: Not analysed

1. Includes background concentration.
2. Katestone 2020.
3. Sensitive receptor R2004 is located within the Project area near the northern boundary. Katestone 2021.

6.2. Point of exposure estimates

The equations used in the exposure modelling are presented in Table 4.

Table 4: Exposure modelling equations

Equation No.	Description	Equation
Estimation of COPC concentration in soil		
1	Soil COPC concentration at end of mine lifetime	$Cs = \frac{PDR_x \times X}{K_s \times SD \times BD \times T_t}$
2	Particle deposition rate	$PDR = GLC_x \times DR \times CF1$
3	Soil accumulation function	$X = \left[\frac{e^{-K_s \times T_f} - e^{K_x \times T_0}}{K_s}\right] + T_t$
4	Soil elimination constant	$K_s = \frac{Ln(2)}{T^{0.5}}$
Estimation of COPC concentration in edible produce or pasture		
5	Concentration COPC deposited on vegetation (edible crops or pasture)	$C_{dc,dp} = \frac{PDR \times F_{c,p} \times [1 - e^{-kT}]}{k \times Y}$
6	Concentration COPC translocated from soil to plant via roots	$C_{tr} = C_s \times UF_x$
7	Chronic daily intake via inhalation	$C_i = GLC_x \times BR_{b,m}$
8	Total concentration COPC on/in edible crop	$C_c = C_{dc} + Ctr_x$
9	Total concentration COPC on/in pasture vegetation	$C_p = C_{dp} + Ctr_x$
Estimation of COPC concentration in animal products		
10	Concentration in animal produce: beef or dairy milk	$C_{ap(b,m)} = (F_p \times IR_{pb,pd} \times C_p + IR_{sb,sd} \times C_s \times B + Ci_{b,d}) \times TC_x$

6.3. Modelling parameters

The modelling inputs and parameters adopted for this evaluation using the equations in Table 4 are presented in Table 5. Note the exposure modelling parameters are presented in Section 6.4.

Table 5: Modelling parameters

Parameter			Value	Reference / Rational
Code	Description	Units		
B	Bioavailability of chemical ingested	[unitless]	100%	Maximum assumed unless noted otherwise.
BD	Soil bulk density	[kg/m^3]	1625	Based on sand, sandy clay. Freibel et al (2011)
BRb	Inhalation rate beef cattle	[m^3/d]	107	OEHHA 2015

Parameter			Value	Reference / Rational
Code	Description	Units		
BRd	Inhalation rate dairy cattle	[m^3/d]	115	OEHHA 2015
Capb	Concentration in beef products	[µg/kg]	Calculated	Equation 10
Capm	Concentration in dairy milk	[µg/kg]	Calculated	Equation 10
Cdc	Concentration dust deposited on crops	[mg/kg]	Calculated	Equation 5
Cdp	Concentration dust deposited on pasture	[mg/kg]	Calculated	Equation 5
CF1	Conversion factor	[sec/day]	86,400	-
Cib	Chronic daily intake, inhalation beef cattle	[µg/day]	Calculated	Equation 7
Cid	Chronic daily intake, inhalation dairy cattle	[µg/day]	Calculated	Equation 7
Cc	Concentration in crops	[µg/kg]	Calculated	Equation 8
Cp	Concentration in pasture	[µg/kg]	Calculated	Equation 9
Cs	Concentration in soil	[µg/kg]	Calculated	Equation 1
Ctr	Uptake/translocation from soil via roots	[µg/kg]	Calculated (Wet weight)	Equation 6
DR	Vertical deposition rate	[m/sec]	0.02	Conservative assumption based on regional conditions (1)
e	Base of natural log	-	≈ 2.718	-
Fc	Fraction of crop plant surface area	[unitless]	0.2	Based on leafy produce. es. Baes et al 1984, OEHHA 2015
Fp	Fraction of pasture surface area	[unitless]	0.7	Based on pasture OEHHA 2015
Fp	Fraction of cattle diet pasture	[unitless]	100%	Maximum assumed
GLC	Ground level air concentration	[µg/m^3]	Chemical specific	Refer to Table 3
IRpb	Ingestion rate pasture by beef cattle	[kg/d]	9	OEHHA 2015
IRpd	Ingestion rate pasture by dairy cattle	[kg/d]	22	OEHHA 2015
IRsb	Ingestion rate of soil by beef cattle	[kg/d]	0.45	Based on 5% of pasture intake. OEHHA 2015
IRsd	Ingestion rate of soil by dairy cattle	[kg/d]	1.1	Based on 5% of pasture intake. OEHHA 2015
k	Weathering loss constant	[$days^{-1}$]	0.1	Based on geometric mean of particulate half-lives. Baes et al 1984, OEHHA 2012
Ks	Soil elimination constant	[day^{-1}]	6.93E-09	Equation 4

Parameter			Value	Reference / Rational
Code	Description	Units		
PDR	Particle deposition rate	[µg/m²/day]	Calculated	Equation 2
SD	Soil mixing depth	[m]	0.15	Based on agricultural area. OEHHA 2015
T	Growth period of crop	[days]	45	OEHHA 2015
T_0	The start of soil accumulation	[d]	0	Time project dust generation commences.
$T^{0.5}$	Chemical half-life in soil	[days]	100,000,000	Assumes minimal loss (leaching, weathering). OEHHA 2015
TCb	Beef transfer coefficient	[day/µg]	Chemical specific.	Refer to Based on regional meteorological conditions and predominantly cleared areas with pockets of eucalyptus forest (Katestone, 2020). Table 6
TCm	Milk transfer coefficient	[day/µg]	Chemical specific.	Refer to Based on regional meteorological conditions and predominantly cleared areas with pockets of eucalyptus forest (Katestone, 2020). Table 6
T_f	Soil accumulation period	[days]	7300	Based on the 20-year mine life
Tt	Accumulation time	[days]	7300	Based on the 20 year mine life
UFx	Uptake factor from soil via roots	[unitless]	Chemical specific.	Soil to wet plant. Refer to Based on regional meteorological conditions and predominantly cleared areas with pockets of eucalyptus forest (Katestone, 2020). Table 6
X	Integral function for soil accumulation	[days]	Calculated	Equation 3
Y	Crop yield	[kg/m²]	2	Based on above ground crops. OEHHA 2015

1 Based on regional meteorological conditions and predominantly cleared areas with pockets of eucalyptus forest (Katestone, 2020).

Table 6: COPC specific uptake factors and transfer coefficients to animal products.

Chemical	Soil-to-Wet Plant Uptake Factor (1) [unitless]	Beef Transfer Coefficient (1) [day/kg]	Milk Transfer Coefficient (1) [day/kg]
	[UF]	[TCb]	[TCm]
Arsenic	0.01	0.002	0.00006
Cadmium	0.125	0.00055	0.001
Cerium	0.0025	0.00075	0.00002
Chromium (2)	0.00188	0.0055	0.0015
Cobalt	0.005	0.02	0.002
Copper	0.1	0.01	0.0015
Lanthanum (3)	0.0025	0.00075	0.00002
Lead	0.01125	0.0004	0.00025
Manganese	0.0625	0.0004	0.00035
Nickel	0.015	0.006	0.001
Selenium	0.00625	0.015	0.004
Tin	0.0075	0.001	0.001
Titanium	0.00138	0.03	0.01
Tungsten	0.01125	0.045	0.0003
Uranium	0.00213	0.0002	0.0006
Vanadium	0.00138	0.0025	0.00002
Zinc & Zinc Oxide	0.264	0.1	2.7E-09
Zirconium	0.0005	0.0055	0.00003

1. RAIS, website accessed April 2021.
2. Based on Cr III
3. Not established therefore Cerium values have been adopted based on similar chemical properties for low water solubility and molecular weight.

6.4. Exposure parameters

On the basis the most sensitive receptor populations in the vicinity of the project are residential occupants in a rural setting, the health risk evaluation selected exposure inputs that were considered to be generally reasonable and conservative. The equations used to estimate the chronic daily intakes (CDI) are presented in Table 7.

Table 7: Estimation of Chronic Daily Intakes

Equation No.	Description	Equation
Estimation of Chronic Daily Intakes		
11	Inhalation of contaminants in particulates	$EC = \frac{GLC_x \times ET \times EF \times ED}{AT}$
12	Ingestion of soil, produce or animal product (beef or milk)	$CDI_{ing\ (s,v,b,m)} = \frac{C_{s,v,ap} \times B_o \times IR_{s,v,b,m} \times EF \times ED \times F_{s,v,b,m}}{BW \times AT}$

The adopted exposure inputs are presented in Table 8.

Table 8: Exposure parameters - Residential receptors

Parameter			Value		Reference / Rational
Code	Description	Units	Child	Adult worker	
EC	Exposure concentration	[µg/m³]	Calculated		Equation 1
GLC	COPC concentration in air at ground level	[µg/m³]	Modelled: chemical specific		Maximum concentration at any sensitive receptor. Refer to Table 3
ET	Exposure time outdoors	[hour/day]	8	10	Conservative assumption based on a rural residential setting.
EF	Exposure frequency	[days/year]	365		Maximum assumption
ED	Exposure duration	[years]	6	30	enHealth 2012b
AT	Averaging time (period over which exposure is averaged)	[days]	Calculated		AT = ED x 365 days/year
CF2	Conversion Factor	[hours/day]	24		-
CDIing	Chronic daily intake – ingestion of soil, vegetables, beef or milk	[µg/kg-day]	Calculated		Equation 2
IRs	Soil ingestion rate	[Kg/day]	0.0001	0.0001	enHealth 2012b, RAIS 2021 based on outdoor worker
IRv	Vegetable ingestion rate	[Kg/day]	0.055	0.153	Based on green vegetables. ASC NEPM (2013)
IRb	Beef ingestion rate	[Kg/day]	0.059	0.124	Median values (1). ABS 2011-2012 NNPAS.
IRm	Milk ingestion rate	[Kg/day]	0.702	0.716	Mean values (1). ABS 2011-2012 NNPAS.
Fs	Fraction of soil ingested from impacted area	[%]	100	100	Conservative assumption
Fv	Fraction of crops ingested from impacted area	[%]	75	75	Conservative assumption based on rural residents
Fb	Fraction of beef ingested from impacted area	[%]	75	75	Conservative assumption based on rural residents

Parameter			Value		Reference / Rational
Code	Description	Units	Child	Adult worker	
Fm	Fraction of milk ingested from impacted area	[%]	50	50	Conservative assumption based on rural residents
BW	Body weight	[Kg]	15	70	ASC NEPM (2013) Child based on 2-3 year old.

1. Child value is based on 2-6 years age range and adult value is based on persons aged 2 years and over. Value excludes survey respondents who indicated they do not consume this product.

6.5. Estimated concentrations in soil, crops and animal products

The estimated COPC concentrations deposited on soil and vegetation are presented in Table 9, in addition to the calculated concentrations ingested or inhaled by cattle. Transfer co-efficients were also used to estimate the total COCP concentration in beef and milk as shown in the last two columns of Table 9.

Table 9: Calculated concentrations in soil, crops and animal products

Parameter	Max concentration ground level [(1)] [ug/m^2]	Particle Deposition Rate [ug/m2/day]	Soil concentration of COPC [ug/kg]	Deposition on crops [ug/kg]	Deposition on pasture [ug/kg]	Translocation concentration in crop [ug/kg]	Concentration in/on Crops [ug/kg]	Concentration in/on pasture [ug/kg]	CDI: Inhalation beef cattle [ug/d]	CDI: Inhalation dairy cattle [ug/d]	Concentration of COPC in beef products [ug/Kg]	Concentration of COPC in dairy milk [ug/Kg]
Code	**[GLC]**	**[PDR]**	**[Cds]**	**[Cdc]**	**[Cdp]**	**[Ctr]**	**[Cc]**	**[Cp]**	**[Cib]**	**[Cid]**	**[Capb]**	**[Capm]**
Arsenic	0.002	3.28	3.25	11.36	49.16	0.49	3.74	11.86	0.20	0.22	0.26	0.02
Cadmium	0.000	0.38	0.38	1.32	5.69	0.71	1.09	2.03	0.02	0.03	0.01	0.05
Cerium	0.001	2.07	2.05	7.18	31.05	0.08	2.13	7.25	0.13	0.14	0.06	0.004
Chromium	0.005	8.99	8.89	31.10	134.55	0.25	9.14	31.35	0.56	0.60	1.89	1.26
Cobalt	0.001	2.25	2.22	7.78	33.64	0.17	2.39	7.94	0.14	0.15	1.74	0.42
Copper	0.002	3.11	3.08	10.77	46.58	4.66	7.73	15.42	0.19	0.21	1.60	0.59
Lanthanum	0.001	1.00	0.99	3.47	15.01	0.04	1.03	3.51	0.06	0.07	0.03	0.002
Lead	0.003	4.49	4.44	15.55	67.28	0.76	5.20	16.31	0.28	0.30	0.07	0.11
Manganese	0.006	9.50	9.40	32.89	142.31	8.89	18.29	41.79	0.59	0.63	0.18	0.38
Nickel	0.002	2.94	2.90	10.17	43.99	0.66	3.56	10.83	0.18	0.20	0.70	0.29
Selenium	0.002	3.80	3.76	13.16	56.93	0.36	4.12	13.51	0.24	0.25	2.21	1.44
Tin	0.005	8.12	8.03	28.11	121.61	0.91	8.94	29.02	0.50	0.54	0.32	0.77
Tungsten	0.006	10.54	10.42	36.48	157.84	1.78	12.20	38.26	0.65	0.70	18.72	0.30

Parameter	Max concentration ground level [1] [ug/m^2]	Particle Deposition Rate [ug/m2/day]	Soil concentration of COPC [ug/kg]	Deposition on crops [ug/kg]	Deposition on pasture [ug/kg]	Translocation concentration in crop [ug/kg]	Concentration in/on Crops [ug/kg]	Concentration in/on pasture [ug/kg]	CDI: Inhalation beef cattle [ug/d]	CDI: Inhalation dairy cattle [ug/d]	Concentration of COPC in beef products [ug/Kg]	Concentration of COPC in dairy milk [ug/Kg]
Uranium	0.002	3.80	3.76	13.16	56.93	0.12	3.88	13.28	0.24	0.25	0.03	0.21
Vanadium	0.003	5.18	5.13	17.94	77.63	0.11	5.23	18.05	0.32	0.35	0.49	0.01
Zinc	0.061	105.41	104.24	364.83	1578.39	416.70	520.93	781.52	6.53	7.02	775.05	0.0001
Zinc Oxide	0.230	397.44	393.02	1375.59	5951.31	1571.15	1964.17	2946.73	24.61	26.45	2922.33	0.0002
Zirconium	0.005	7.95	7.86	27.51	119.03	0.06	7.92	27.57	0.49	0.53	1.66	0.02

1. Maximum concentration predicted at Year 5, Year 8 and Year 12. (Katestone 2020, Katestone 2021)

The exposure modelling calculations are presented in Attachment A

7. Risk characterisation

The risk of health effects from threshold chemical exposure is expressed in terms of the Hazard Quotient (HQ). The HQ is the ratio of the estimated exposure concentration (EC) to the tolerable concentration (TC), or the estimated chronic daily intake (CDI) to the TRV. The HQ is calculated as presented in Table 10.

Table 10: Equation Used to Calculate the Hazard Quotient

Inhalation	
Equation 12 (USEPA, 2009)	$HQ = \frac{EC}{TC \times TIA}$
Direct or indirect ingestion	
Equation 13 (USEPA, 1989)	$HQ = \frac{CDI}{TDI \times TIA}$

Where,

HQ	= Hazard Quotient for a pathway specific exposure (unitless)
EC	= Exposure Concentration (µg/m^3)
TC	= Tolerable Concentration (µg/m^3)
CDI	= Chronic Daily Intake (mg/kg/day)
TDI	= Tolerable Daily Intake (mg/kg/day)
TIA	= Tolerable Intake % Allocated to Contaminated Sites

To estimate the additive effect of exposure to multiple COPCs via multiple pathways, the HQs can be summed to obtain a Hazard Index (HI) for a particular receptor. This assumes additivity in the toxicological outcomes following concurrent exposures. As a conservative approach, the HQs for all pathways for each COPC and receptor are considered together. However, the additivity of all pathways and COPCs is likely to only be relevant when COPCs have a common toxic effect or target organ.

Where HI is less than 1, there is unlikely to be any adverse health effects associated with exposure to the chemicals of concern. However, a HI exceeding 1 does not necessarily indicate an actual risk but rather a potential adverse health outcome requiring additional assessment.

The calculated HQs and calculated HI associated with the on-site exposure to COPC exhibiting thresholds are presented in Attachment A and are summarised in Table 11 for young children and Table 12 for adult workers.

Table 11: Estimated Hazard Quotients and Total Hazard Index – Residential Receptors – Young Child

COPC	Inhalation of COPC in air	Incidental ingestion soil	Consumption local crops	Consumption local beef	Consumption local raw dairy milk	Total HI multiple exposure pathways
Arsenic	6.33E-04	3.28E-04	1.03E-02	7.61E-04	4.42E-04	**0.01**
Cadmium	1.83E-02	1.19E-04	9.35E-03	1.06E-04	3.72E-03	**0.03**
Cerium	4.44E-04	-	-	-	-	**<0.01**
Chromium	1.73E-02	6.64E-07	1.86E-05	4.13E-06	2.18E-05	**0.02**
Cobalt	7.22E-02	2.00E-04	5.87E-03	4.57E-03	8.85E-03	**0.09**
Copper	4.08E-06	7.39E-06	5.06E-04	1.12E-04	3.27E-04	**<0.01**
Lanthanum	9.21E-07	1.67E-07	4.71E-06	1.42E-07	7.31E-08	**<0.01**
Lead	1.08E-04	1.95E-04	6.22E-03	9.10E-05	1.10E-03	**<0.01**
Manganese	1.53E-02	1.36E-05	7.19E-04	7.43E-06	1.26E-04	**0.02**
Nickel	3.54E-02	4.07E-05	1.36E-03	2.89E-04	9.32E-04	**0.04**
Selenium	8.73E-05	1.58E-04	4.72E-03	2.72E-03	1.40E-02	**0.02**
Tin	5.80E-06	1.50E-06	4.55E-05	1.73E-06	3.35E-05	**<0.01**
Tungsten	7.26E-04	6.58E-04	2.10E-02	3.45E-02	4.46E-03	**0.06**
Uranium	1.83E-02	1.90E-05	5.34E-04	4.29E-06	2.49E-04	0.02
Vanadium	1.43E-03	1.04E-04	2.88E-03	2.92E-04	4.52E-05	**<0.01**
Zinc	5.81E-05	1.05E-04	1.43E-02	2.29E-02	1.19E-08	**0.04**
Zinc oxide	2.19E-04	3.97E-04	5.40E-02	8.62E-02	4.47E-08	**0.14**
Zirconium	5.48E-03	9.92E-04	2.72E-02	6.13E-03	6.48E-04	**0.04**
Total HI for all COPCs and exposure pathways						**0.54**

Total HI = sum of all HQ; Shaded cells indicate a potential health risk has been identified

Table 12: Estimated Hazard Quotients and Total Hazard Index – Adult worker

COPC	Inhalation of COPC in air	Incidental ingestion soil	Consumption on local crops	Consumption local beef	Consumption local raw dairy milk	Total HI multiple exposure pathways
Arsenic	7.92E-04	7.02E-05	6.13E-03	3.43E-04	9.67E-05	**<0.01**
Cadmium	2.29E-02	2.54E-05	5.57E-03	4.76E-05	8.13E-04	**0.03**
Cerium	5.56E-04	-	-	-	-	**<0.01**
Chromium	2.17E-02	1.42E-07	1.11E-05	1.86E-06	4.76E-06	**0.02**
Cobalt	9.03E-02	4.29E-05	3.50E-03	2.06E-03	1.94E-03	**0.10**
Copper	5.10E-06	1.58E-06	3.02E-04	5.06E-05	7.14E-05	**<0.01**
Lanthanum	1.15E-06	3.57E-08	2.81E-06	6.37E-08	1.60E-08	**<0.01**
Lead	1.35E-04	4.18E-05	3.71E-03	4.10E-05	2.41E-04	**<0.01**
Manganese	1.91E-02	2.90E-06	4.28E-04	3.35E-06	2.75E-05	**0.02**
Nickel	4.43E-02	8.73E-06	8.12E-04	1.30E-04	2.04E-04	**0.05**
Selenium	1.09E-04	3.39E-05	2.81E-03	1.22E-03	3.07E-03	**<0.01**
Tin	7.25E-06	3.22E-07	2.71E-05	7.79E-07	7.32E-06	**<0.01**
Tungsten	9.08E-04	1.41E-04	1.25E-02	1.55E-02	9.74E-04	**0.03**
Uranium	2.29E-02	4.07E-06	3.18E-04	1.93E-06	5.45E-05	**0.02**
Vanadium	1.79E-03	2.22E-05	1.72E-03	1.31E-04	9.88E-06	**<0.01**
Zinc	7.26E-05	2.25E-05	8.54E-03	1.03E-02	2.59E-09	**0.02**
Zinc oxide	2.74E-04	8.50E-05	3.22E-02	3.88E-02	9.77E-09	**0.07**
Zirconium	6.85E-03	2.13E-04	1.62E-02	2.76E-03	1.42E-04	**0.03**
Total HI for all COPCs and exposure pathways						**0.40**

Total HI = sum of all HQ; Shaded cells indicate a potential health risk has been identified

On the basis the sum of the HQ calculated for each COPC is below the acceptable HI of 1 for both young children and adult workers, future exposures via multiple pathways is considered acceptable.

The additivity of HIs calculated for all pathways and for multiple COPCs is only likely to be relevant where the COPCs have a toxic effect on the same target organ. To sum the HIs estimated for every COPC and every pathway is a conservative approach given the likely variance in toxicity and effected organs/systems. It is noted the total HI for all COPCs across all exposure pathways in this instance does not exceed an HI of 1.

Refer to Attachment A for summed HI for COPCs calculated for each exposure pathway.

8. Uncertainties

An evaluation of the key uncertainties of this risk assessment is presented below in Table 13.

Table 13: Uncertainty Assessment

Parameter	Evaluation of Uncertainty
Acceptable intake values	The toxicity criteria used in this assessment are generally regarded as highly conservative. They are typically derived from exposure levels shown to cause "no adverse effect" following studies of chronic exposure in animals or humans. Safety factors, extending several orders of magnitude may be taken into account for issues related to data extrapolation. Acceptable intake values have been developed by various regulatory agencies such as the US Environmental Protection Agency (USEPA) and the World Health Organisation (WHO). These criteria may be different due to different methods of derivation. The selection of toxicological source information is in accordance with the NEPM.
Chemical composition	The chemical composition of metals and their compounds in dust are not available therefore the selection of appropriate TRV are based on the element and related compounds that are most likely to be found in natural soils and mineral sands. For example, although titanium is the ninth most abundant element in the earth's crust and was measured in relatively high levels in air, the elemental and TiO_2 forms are known to have very low toxicity in comparison to the manufactured titanium tetrachloride which is not found naturally .
Uptake factors and transfer coefficients	The uptake factors and transfer coefficients were selected from the RAIS website due to the larger number of chemicals listed. In most instances the values were more conservative than those presented in the OEHHA 2015 guidance and are therefore likely to overestimate the concentrations in crops, milk or beef.
Exposure Assumptions	A number of conservative exposure assumptions were included in the risk assessment. For example, it was assumed that in the residential setting the same individual would be exposed to the same air, soil and local food concentration for 8 hours/day, 365 days/year for over a 20 - 30 year period. When combined, the assumptions deliberately overestimate the most likely exposure intakes.
COPC Concentrations	The maximum concentrations of each COPC modelled at sensitive receptor populations in Years 5, 8 and 12 of mine operations were utilised in this assessment. It is unlikely these maximum concentrations will be present in ground level air at any receptor location for the 20 year life of the mine suggesting this would be a worst case scenario.

Taken as a whole, the assumptions used in the risk assessment are considered to be conservative and tend to adopt the Precautionary Principle (enHealth, 2012a) in estimating risk. The risk assessment approach presented does not consider a fully probabilistic estimate of risk, but presents conditional estimates based on a number of assumptions regarding exposure and toxicity. Thus, it is necessary to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates into perspective. Risk assessment methodologies reflect an iterative process of development and as such it should be recognised that this exposure assessment and risk assessment are based on existing methodologies and their limitations which may be subject to change.

9. Conclusion

Based on the available information exposure assumptions and constraints of the exposure assessment model, the potential health risks to the identified sensitive receptor populations associated with the predicted COPC concentrations in airborne particulates and fallout, as presented in this technical note, are as follows:

- Consumption of beef and milk from livestock raised in the regional area, that may have ingested impacted pasture, soil or inhaled particulates associated with future project activities is considered to be low and acceptable.
- The deposition of dust on crops and uptake of metals in soil associated with dust fallout and subsequent ingestion by sensitive receptor populations is considered to be low and acceptable.
- Inhalation of COPC in airborne particulates associated with future project activities is considered to be low and acceptable.
- The incidental ingestion of COPC impacted soil associated with fallout from future project activities is considered to be low and acceptable.

The potential future exposures to sensitive receptor populations to the selected COPCs predicted in air, associated with the multiple exposure pathways evaluated in this technical note, are considered to be low and acceptable.

10. Limitations

The risk assessment has been limited to addressing the impacts of selected substances, to a specific assumed receptor population under a defined exposure scenario, based on information available at the time of the assessment. The risk assessment approach presented does not consider a fully probabilistic estimate of risk, but presents conditional estimates based on a number of assumptions regarding exposure and toxicity consistent with the nationally endorsed regulatory approach. Further assessments would be required to assess risk where site uses vary from the assumed site conditions and/or exposure settings used in this risk assessment.

This report must be read in conjunction with the attached ‘Important information about your Coffey Environments Report’, as provided in Attachment B.

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Attachment A: Risk Assessment Exposure Modelling

Estimation of Hazard Index
Non Threshold Health Effects

Fingerboards Mineral Sand Project
Southeast Victoria

Receptor			Regional	Residential Occupant / Agricultural Worker
Scenario ID		7	SNRig n	Soil Max concOther
				Incidental ingestion soil
Parameters	**Units**		**Child**	**Adult**
Body Weight	kg		15	70
Exposure Duration	years		6	30
Ingestion Rate	kg/day		0.0001	0.0001
Exposure Frequency	days/year		365	365
Averaging Time	years		6	30
Fraction of food from local contaminated source	unitless		1	1

$$CDI_{ing\,(s,v,b,m)} = \frac{C_{s,v,ap} \times B_o \times IR_{s,v,b,m} \times EF \times ED \times F_{s,v,b,m}}{BW \times AT}$$

Chemical	Concentration Food	Bioavailability	Tolerable Intake	Estimated Chronic Daily Intake - Terrestrial Food	(#WGI#Doorfdwhg#wr# Frqwdp lqdwhg#Vlwhv	Non Threshold Health Effects
	µg/kg	(unitless)	µj2nj0gd|	+µj2nj0gd|,	(unitless)	HQ
Child						**Child**
Arsenic	49.2	100%	2.00	0.00033	0.50	0.0003
Cadmium	5.7	100%	0.80	0.00004	0.40	0.0001
Cerium	31.1	100%	NE	0.00021	1.00	
Chromium	134.6	100%	1500	0.00090	0.90	0.000001
Cobalt	33.6	100%	1.40	0.00022	0.80	0.0002
Copper	46.6	100%	140	0.00031	0.30	0.00001
Lanthanum	15.0	10%	60	0.00001	1.00	0.0000002
Lead	67.3	100%	3.50	0.00045	0.66	0.0002
Manganese	142.3	100%	140	0.00095	0.50	0.00001
Nickel	44.0	100%	12	0.00029	0.60	0.00004
Selenium	56.9	100%	6	0.00038	0.40	0.0002
Tin	121.6	100%	600	0.00081	0.90	0.000002
Tungsten	157.8	50%	0.80	0.00053	1.00	0.0007
Uranium	56.9	10%	2	0.00004	1.00	0.00002
Vanadium	77.6	100%	5	0.00052	1.00	0.0001
Zinc	1578.4	100%	500	0.01052	0.20	0.0001
Zinc oxide	5951.3	100%	500	0.03968	0.20	0.0004
Zirconium	119.0	10%	0.08	0.00008	1.00	0.0010
					Total HI	**<0.01**
						0.003
Adult Worker						**Adult Worker**
Arsenic	49.2	100%	2.0	7.02E-05	0.50	0.0001
Cadmium	5.7	100%	0.8	8.13E-06	0.40	0.00003
Cerium	31.1	100%	NE	4.44E-05	1.00	
Chromium	134.6	100%	1500	1.92E-04	0.90	0.0000001
Cobalt	33.6	100%	1.4	4.81E-05	0.80	0.00004
Copper	46.6	100%	140	6.65E-05	0.30	0.000002
Lanthanum	15.0	10%	60	2.14E-06	1.00	0.00000004
Lead	67.3	100%	3.5	9.61E-05	0.66	0.00004
Manganese	142.3	100%	140	2.03E-04	0.50	0.000003
Nickel	44.0	100%	12	6.28E-05	0.60	0.00001
Selenium	56.9	100%	6	8.13E-05	0.40	0.00003
Tin	121.6	100%	600	1.74E-04	0.90	0.0000003
Tungsten	157.8	50%	0.8	1.13E-04	1.00	0.0001
Uranium	56.9	10%	2.0	8.13E-06	1.00	0.000004
Vanadium	77.6	100%	5.0	1.11E-04	1.00	0.00002
Zinc	1578.4	100%	500	2.25E-03	0.20	0.00002
Zinc oxide	5951.3	100%	500	8.50E-03	0.20	0.0001
Zirconium	119.0	10%	0.1	1.70E-05	1.00	0.0002
					Total HI	**<0.01**
						0.0007

Estimation of Hazard Index
Non Threshold Health Effects

Fingerboards Mineral Sand Project
Southeast Victoria

Receptor			Regional	Residential Occupant / Agricultural Worker
Scenario ID		1	VNRig n	Veg
				Ingestion local crops
Parameters	**Units**		**Child**	**Adult**
Body Weight	kg		15	70
Exposure Duration	years		6	30
Ingestion Rate	kg/day		0.055	0.153
Exposure Frequency	days/year		365	365
Averaging Time	years		6	30
Fraction of food from local contaminated source	unitless		0.75	0.75

$$CDI_{ing\,(s,v,b,m)} = \frac{C_{s,v,ap} \times B_o \times IR_{s,v,b,m} \times EF \times ED \times F_{s,v,b,m}}{BW \times AT}$$

Chemical	Concentration Food	Bioavailability	Tolerable Intake	Estimated Chronic Daily Intake - Terrestrial Food	(#WGL#Dorfdwhg#wr# Frqwdp lqdwhg#Vlwhv	Non Threshold Health Effects
	µg/kg	(unitless)	µj2nj0gd|	+µj2nj0gd|,	(unitless)	HQ
Child						**Child**
Arsenic	3.7	100%	2.0	0.01	0.50	0.010
Cadmium	1.1	100%	0.8	0.003	0.40	0.009
Cerium	2.1	100%	NE	0.01	1.00	
Chromium	9.1	100%	1500	0.03	0.90	0.00002
Cobalt	2.4	100%	1.4	0.01	0.80	0.006
Copper	7.7	100%	140	0.02	0.30	0.001
Lanthanum	1.0	10%	60	0.0003	1.00	0.000005
Lead	5.2	100%	3.5	0.01	0.66	0.006
Manganese	18.3	100%	140	0.05	0.50	0.001
Nickel	3.6	100%	12	0.01	0.60	0.001
Selenium	4.1	100%	6	0.01	0.40	0.005
Tin	8.9	100%	600	0.02	0.90	0.00005
Tungsten	12.2	50%	0.8	0.02	1.00	0.021
Uranium	3.9	10%	2.0	0.001	1.00	0.001
Vanadium	5.2	100%	5.0	0.01	1.00	0.003
Zinc	520.9	100%	500	1.43	0.20	0.01
Zinc oxide	1964.2	100%	500	5.40	0.20	0.05
Zirconium	7.9	10%	0.1	0.002	1.00	0.03
					Total HI	**0.16**
						0.159
Adult Worker						**Adult Worker**
Arsenic	3.7	100%	2.0	0.01	0.50	0.01
Cadmium	1.1	100%	0.8	0.002	0.40	0.01
Cerium	2.1	100%	NE	0.003	1.00	
Chromium	9.1	100%	1500	0.01	0.90	0.00001
Cobalt	2.4	100%	1.4	0.004	0.80	0.003
Copper	7.7	100%	140	0.01	0.30	0.0003
Lanthanum	1.0	10%	60	0.0002	1.00	0.000003
Lead	5.2	100%	3.5	0.01	0.66	0.004
Manganese	18.3	100%	140	0.03	0.50	0.0004
Nickel	3.6	100%	12	0.01	0.60	0.001
Selenium	4.1	100%	6	0.01	0.40	0.003
Tin	8.9	100%	600	0.01	0.90	0.00003
Tungsten	12.2	50%	0.8	0.01	1.00	0.01
Uranium	3.9	10%	2	0.001	1.00	0.0003
Vanadium	5.2	100%	5	0.01	1.00	0.002
Zinc	520.9	100%	500	0.85	0.20	0.01
Zinc oxide	1964.2	100%	500	3.22	0.20	0.03
Zirconium	7.9	10%	0.08	0.001	1.00	0.02
					Total HI	**0.09**
						0.09

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Estimation of Hazard Index
Non Threshold Health Effects

Fingerboards Mineral Sand Project
Southeast Victoria

Receptor			Regional	Residential Occupant / Agricultural Worker
Scenario ID		3	BNRig n	Beef
				Ingestion local beef

Parameters	**Units**	**Child**	**Adult**
Body Weight	kg	15	70
Exposure Duration	years	6	30
Ingestion Rate	kg/day	0.059	0.124
Exposure Frequency	days/year	365	365
Averaging Time	years	6	30
Fraction of food from local contaminated source	unitless	0.75	0.75

$$CDI_{ing\,(s,v,b,m)} = \frac{C_{s,v,ap} \times B_o \times IR_{s,v,b,m} \times EF \times ED \times F_{s,v,b,m}}{BW \times AT}$$

Chemical	Concentration Food	Bioavailability	Tolerable Intake	Estimated Chronic Daily Intake - Terrestrial Food	(#WGI#Dcrfdwhg#wr# Frqwdp lqdwhg#V lwhv	Non Threshold Health Effects
	µg/kg	(unitless)	µj2nj0gd|	+µj2nj0gd|,	(unitless)	HQ
Child						**Child**
Arsenic	0.3	100%	2.0	0.001	0.50	0.0008
Cadmium	0.01	100%	0.8	0.00003	0.40	0.0001
Cerium	0.1	100%	NE	0.0002	1.00	
Chromium	1.9	100%	1500	0.006	0.90	0.00000
Cobalt	1.7	100%	1.4	0.005	0.80	0.005
Copper	1.6	100%	140.0	0.005	0.30	0.0001
Lanthanum	0.03	10%	60	0.00001	1.00	0.0000001
Lead	0.1	100%	3.5	0.0002	0.66	0.0001
Manganese	0.2	100%	140	0.001	0.50	0.00001
Nickel	0.7	100%	12	0.002	0.60	0.0003
Selenium	2.2	100%	6	0.007	0.40	0.003
Tin	0.3	100%	600	0.001	0.90	0.000002
Tungsten	18.7	50%	0.8	0.03	1.00	0.03
Uranium	0.03	10%	2.0	0.00001	1.00	0.000004
Vanadium	0.5	100%	5.0	0.001	1.00	0.0003
Zinc	775.1	100%	500.0	2.3	0.20	0.02
Zinc oxide	2922.3	100%	500.0	8.6	0.20	0.09
Zirconium	1.7	10%	0.1	0.0005	1.00	0.006
					Total HI	**0.16**
						0.159
Adult worker						**Adult worker**
Arsenic	0.3	100%	2.0	0.0003	0.50	0.0003
Cadmium	0.01	100%	0.8	0.00002	0.40	0.00005
Cerium	0.1	100%	NE	0.0001	1.00	
Chromium	1.9	100%	1500	0.003	0.90	0.000002
Cobalt	1.7	100%	1.4	0.002	0.80	0.002
Copper	1.6	100%	140	0.002	0.30	0.0001
Lanthanum	0.03	10%	60	0.000004	1.00	0.0000001
Lead	0.1	100%	3.5	0.0001	0.66	0.00004
Manganese	0.2	100%	140	0.0002	0.50	0.000003
Nickel	0.7	100%	12	0.001	0.60	0.0001
Selenium	2.2	100%	6	0.003	0.40	0.001
Tin	0.3	100%	600	0.0004	0.90	0.000001
Tungsten	18.7	50%	0.8	0.012	1.00	0.02
Uranium	0.03	10%	2.0	0.000004	1.00	0.000002
Vanadium	0.5	100%	5.0	0.001	1.00	0.0001
Zinc	775.1	100%	500	1.0	0.20	0.01
Zinc oxide	2922.3	100%	500	3.9	0.20	0.04
Zirconium	1.7	10%	0.1	0.0002	1.00	0.003
					Total HI	**0.07**
						0.071

Estimation of Hazard Index
Non Threshold Health Effects

Fingerboards Mineral Sand Project
Southeast Victoria

Receptor		Regional	Residential Occupant / Agricultural Worker	
Scenario ID	5	MNRig n	Milk	
				Ingestion local dairy milk

Parameters	**Units**	**Child**	**Adult**
Body Weight	kg	15	70
Exposure Duration	years	6	30
Ingestion Rate	kg/day	0.702	0.716
Exposure Frequency	days/year	365	365
Averaging Time	years	6	30
Fraction of food from local contaminated source	unitless	0.5	0.5

$$CDI_{ing\,(s.v.b.m)} = \frac{C_{s.v.ap} \times B_o \times IR_{s.v.b.m} \times EF \times ED \times F_{s.v.b.m}}{BW \times AT}$$

Chemical	Concentration Food	Bioavailability	Tolerable Intake	Estimated Chronic Daily Intake - Terrestrial Food	(#\GI#Dorfdwhg#wr# Frqwdp lqdwhg#Vlwhv	Non Threshold Health Effects
	µg/kg	(unitless)	µj2nj@gd|	+µj2nj@gd|,	(unitless)	HQ
Child						**Child**
Arsenic	0.02	100%	2	0.0004	0.50	0.0004
Cadmium	0.05	100%	0.8	0.001	0.40	0.004
Cerium	0.00	100%	NE	0.00009	1.00	
Chromium	1.26	100%	1500	0.03	0.90	0.00002
Cobalt	0.42	100%	1.4	0.01	0.80	0.009
Copper	0.59	100%	140	0.01	0.30	0.0003
Lanthanum	0.00	10%	60	0.000004	1.00	0.0000001
Lead	0.11	100%	3.5	0.003	0.66	0.001
Manganese	0.38	100%	140	0.009	0.50	0.0001
Nickel	0.29	100%	12	0.007	0.60	0.001
Selenium	1.44	100%	6	0.03	0.40	0.01
Tin	0.77	100%	600	0.02	0.90	0.00003
Tungsten	0.30	50%	0.8	0.004	1.00	0.004
Uranium	0.21	10%	2	0.0005	1.00	0.0002
Vanadium	0.01	100%	5	0.0002	1.00	0.00005
Zinc	0.0001	100%	500	0.000001	0.20	0.00000001
Zinc oxide	0.0002	100%	500	0.000004	0.20	0.00000004
Zirconium	0.02	10%	0.1	0.0001	1.00	0.001
					Total HI	**0.04**
						0.035
Adult worker						**Adult worker**
Arsenic	0.02	100%	2.0	0.0001	0.50	0.0001
Cadmium	0.05	100%	0.8	0.0003	0.40	0.001
Cerium	0.004	100%	NE	0.00002	1.00	
Chromium	1.26	100%	1500	0.006	0.90	0.000005
Cobalt	0.42	100%	1.4	0.002	0.80	0.002
Copper	0.59	100%	140	0.003	0.30	0.0001
Lanthanum	0.002	10%	60	0.000001	1.00	0.00000002
Lead	0.11	100%	3.5	0.001	0.66	0.0002
Manganese	0.38	100%	140	0.002	0.50	0.00003
Nickel	0.29	100%	12	0.001	0.60	0.0002
Selenium	1.44	100%	6	0.007	0.40	0.003
Tin	0.77	100%	600	0.004	0.90	0.00001
Tungsten	0.30	50%	0.8	0.001	1.00	0.001
Uranium	0.21	10%	2	0.0001	1.00	0.0001
Vanadium	0.01	100%	5	0.00005	1.00	0.00001
Zinc	0.0001	100%	500	0.0000003	0.20	0.000000003
Zinc oxide	0.0002	100%	500	0.000001	0.20	0.00000001
Zirconium	0.02	10%	0.1	0.00001	1.00	0.0001
					Total HI	**<0.01**
						0.008

Estimation of Hazard Index
Threshold Health Effects

Name: Fingerboards Mineral San
Address: Southeast Victoria

Receptor		Regional	Residential Occupant / Agricultural Worker
Scenario ID	10	PNR-- t	Max Air allRec

Inhalation of airborne particulates

Parameters	**Units**	**Child**	**Adult worker**
Exposure Duration	years	6	30
Exposure Frequency	days/year	365	365
Exposure Time	hours/day	8	10
Averaging Time	years	6	30

Exposure Concentration = Concentration in particulate matter x Exposure Duration x Exposure Frequency x Exposure Time / Averaging Time

$$EC = \frac{GLC_x \times ET \times EF \times ED}{AT}$$

Chemical	Air Conc $\mu g/m^3$	Tolerable Conc $\mu g/m^3$	% TDI Allocated to Contaminated Sites	Exposure Conc (ug/m3)	Estimated HQ
Child					
Arsenic	0.002	1.0	100%	6.33E-04	6.3E-04
Cadmium	0.0002	0.01	80%	7.33E-05	1.8E-02
Cerium	0.001	0.9	100%	4.00E-04	4.4E-04
Chromium	0.005	0.1	100%	1.73E-03	1.7E-02
Cobalt	0.001	0.01	100%	4.33E-04	7.2E-02
Copper	0.002	490	30%	6.00E-04	4.1E-06
Lanthanum	0.001	210	100%	1.93E-04	9.2E-07
Lead	0.003	12.25	66%	8.67E-04	1.1E-04
Manganese	0.006	0.15	80%	1.83E-03	1.5E-02
Nickel	0.002	0.02	80%	5.67E-04	3.5E-02
Selenium	0.002	21	40%	7.33E-04	8.7E-05
Tin	0.005	300	90%	1.57E-03	5.8E-06
Tungsten	0.006	2.8	100%	2.03E-03	7.3E-04
Uranium	0.002	0.04	100%	7.33E-04	1.8E-02
Vanadium	0.003	0.7	100%	1.00E-03	1.4E-03
Zinc	0.06	1750	20%	2.03E-02	5.8E-05
Zinc oxide	0.23	1750	20%	7.67E-02	2.2E-04
Zirconium	0.005	0.28	100%	1.53E-03	5.5E-03
				Total HI	**0.19**
Adult worker					
Arsenic	0.002	1.0	100%	0.001	0.001
Cadmium	0.0002	0.01	80%	0.0001	0.02
Cerium	0.001	0.90	100%	0.001	0.001
Chromium	0.005	0.10	100%	0.002	0.02
Cobalt	0.001	0.01	100%	0.001	0.09
Copper	0.002	490	30%	0.001	0.00001
Lanthanum	0.001	210	100%	0.0002	0.000001
Lead	0.003	12.25	66%	0.001	0.0001
Manganese	0.006	0.15	80%	0.002	0.019
Nickel	0.002	0.02	80%	0.001	0.044
Selenium	0.002	21	40%	0.001	0.0001
Tin	0.005	300	90%	0.002	0.00001
Tungsten	0.006	2.8	100%	0.003	0.001
Uranium	0.002	0.04	100%	0.001	0.023
Vanadium	0.003	0.7	100%	0.001	0.002
Zinc	0.061	1750	20%	0.03	0.0001
Zinc oxide	0.23	1750	20%	0.10	0.0003
Zirconium	0.005	0.28	100%	0.002	0.007
				Total HI	**0.23**

Attachment B: **Important information about your Coffey environmental report**

1 Introduction

This report has been prepared by Coffey for you, as Coffey's client, in accordance with our agreed purpose, scope, schedule and budget.

The report has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared, and the opinions, recommendations and conclusions set out in the report are made in accordance with generally accepted principles and practices of that profession.

The report is based on information gained from environmental conditions (including assessment of some or all of soil, groundwater, vapour and surface water) and supplemented by reported data of the local area and professional experience. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice,

This interpretation is not a complete description of all material on or in the vicinity of the site, due to the inherent variation in spatial and temporal patterns of contaminant presence and impact in the natural environment. Coffey may have also relied on data and other information provided by you and other qualified individuals in preparing this report. Coffey has not verified the accuracy or completeness of such data or information except as otherwise stated in the report. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

2 Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to an adjacent site or area, nor can it be used when the nature of the specific purpose changes from that which we agreed.

For each purpose, a tailored approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible quantify, risks that both recognised and potential contamination posed in the context of the agreed purpose. Such risks may be financial (for example, clean-up costs or constraints on site use) and/or physical (for example, potential health risks to users of the site or the general public).

3 Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Coffey.

The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete.

This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of contamination or other environmental hazards can change over time, as a result of either natural processes or human influence. Coffey should be kept appraised of any such events and should be consulted for further investigations if any changes are noted, particularly during construction activities where excavations often reveal subsurface conditions.

In addition, advancements in professional practice regarding contaminated land and changes in applicable statues and/or guidelines may affect the validity of this report. Consequently, the currency of conclusions and recommendations in this report should be verified if you propose to use this report more than 6 months after its date of issue.

The report does not include the evaluation or assessment of potential geotechnical engineering constraints of the site.

4 Interpretation of factual data

Environmental site assessments identify actual conditions only at those points where samples are taken and on the date collected. Data derived from indirect field measurements, and sometimes other reports on the site, are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions.

Variations in soil and groundwater conditions may occur between test or sample locations and actual conditions may differ from those inferred to exist. No environmental assessment program, no matter how comprehensive, can reveal all subsurface details and anomalies. Similarly, no professional, no matter how well qualified, can reveal what is hidden by earth, rock or changed through time.

The actual interface between different materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

For this reason, parties involved with land acquisition, use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other unrecognised features encountered on site. Coffey would be pleased to assist with any investigation or advice in such circumstances.

5 Recommendations in this report

This report assumes, in accordance with industry practice, that the site conditions recognised through discrete sampling are representative of actual conditions throughout the investigation area. Recommendations are based on the resulting interpretation.

Should further data be obtained that differs from the data on which the report recommendations are based (such as through excavation or other additional assessment), then the recommendations would need to be reviewed and may need to be revised.

6 Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendation and should make their own enquiries and obtain independent advice in relation to such matters.

Coffey assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report.

To avoid misuse of the information presented in your report, we recommend that Coffey be consulted before the report is provided to another party who may not be familiar with the background and the purpose of the report. In particular, an environmental disclosure report for a property vendor may not be suitable for satisfying the needs of that property's purchaser. This report should not be applied for any purpose other than that stated in the report.

7 Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced environmental consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings.

Given Coffey prepared the report and has familiarity with the site, Coffey is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Coffey disowns any responsibility for such misinterpretation.

8 Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs, field testing and laboratory evaluation of samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

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9 Responsibility

Environmental reporting relies on interpretation of factual information using professional judgement and opinion and has a level of uncertainty attached to it, which is much less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. As noted earlier, the recommendations and findings set out in this report should only be regarded as interpretive and should not be taken as accurate and complete information about all environmental media at all depths and locations across the site.