Before the Hearing Commissioners
Appointed by the Grey District Council
and West Coast Regional Council

Under	the Resource Management Act 1991
In the matter of	Resource consent applications by TiGa Minerals and Metals Ltd to establish and operate a mineral sands mine on State Highway 6, Barrytown (RC-2023-0046; LUN3154/23)

Summary Statement and Rebuttal Evidence of Mitchell Robert Ryan

2 February 2024

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Summary of evidence

1 My name is Mitchell Robert Ryan.

2 I prepared a statement of Metallurgical and Radiological evidence dated 19 January 2024. My qualifications and experience are set out in that statement of evidence.

3 I repeat the confirmation given in that statement that I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court.

4 My role in relation to TiGa Minerals and Metals Limited's (**TiGa**) application (the **Application**) has been to provide Metallurgical advice since June 2022.

Summary

5 The samples used by IHC Mining to generate Barrytown Heavy Mineral Concentrate “HMC” were representative of typical high grade and average grade ore from the Barrytown resource. The two HMC samples were consistent in terms of mineral content and specific activity, measuring at 0.66 ± 0.06 Bq/g for the high grade sample’s HMC and 0.70 ± 0.11 Bq/g for the average grade sample’s HMC. The HMC sample produced by NZIMMR measured at 0.87 ± 0.13 Bq/g. This is in-line with the IHC-produced HMC samples. These values are notably lower than the relevant “acceptable levels” of radioactivity. As such, the material is exempt from the provisions of the Radiation Safety Act 2016, and the IAEA Transport Regulations (IAEA SSR6) do not apply.

6 The expected Barrytown ore, slimes, HMC and tailings material as produced by NZIMMR measured at 0.66 ± 0.06 Bq/g, 1.17 ± 0.15 Bq/g, 0.87 ± 0.13 Bq/g and 0.51 ± 0.05 Bq/g, respectively. These values are notably lower than the “acceptable level” of 10 Bq/g for radioactive material. As such, the material is exempt from the provisions of the Radiation Safety Act 2016. As the ore, slimes and tailings material will not be transported off-site, the IAEA Transport Regulations (IAEA SSR6) do not apply.

7 While some degree of natural variation is expected within the produced HMC throughout the Barrytown mine life, the effect on specific activity level is expected to be negligible. Notwithstanding this, TiGa has proposed quarterly testing and reporting of HMC specific activity level to the Consent Authority. It is my opinion that this is sufficient.

8 In response to my above evidence statement dated 19 January 2024, Dr John Phillip Bradley and Mr Brian James Lunt have submitted evidence statements. These statements have been reviewed and taken into consideration with respect to the Barrytown Project’s proposed Conditions of Consent. This rebuttal evidence statement addresses concerns and suggestions raised.

Concerns regarding the variability of radionuclide concentration in the ore and HMC

9 Dr John Philip Bradley raised concerns regarding the variability of radioactivity throughout the orebody and how this may translate to the HMC.

10 As mentioned in my 19 January 2024 evidence statement, approximately 1,500 drill samples spanning the orebody laterally and by depth. The resulting statistical analysis conducted by NZIMMR concluded the typical grade variance of heavy mineral within the orebody to range from 9% (typical low grade zones) to 45% (typical high grade zones), with 19% representing the average. While this is a significant variance in ore body heavy mineral content, the resulting processed HMC was found to be of consistent heavy mineral concentration. The 1.4 tonne sample of average grade ore produced a HMC containing 92% heavy mineral, while the 2.5 tonne sample of high grade ore produced HMC containing 91% heavy mineral.

11 As such, any notable variance in radionuclide concentration in the produced HMC would result from the mineral assemblage of the heavy mineral content within the ore. While the results of the NZIMMR drill programme lie outside of the area of my involvement in the project, it is my understanding that the NZIMMR drill programme found the heavy mineral content throughout ~1,500 samples tested to be reasonably consistent, and that the low-moderate levels of variance in the heavy mineral assemblage would certainly not result in the radionuclide concentration of the material increasing ten- to twenty-fold which is what would be required to cause the HMC to exceed the 'acceptable level' of 10 Bq/g as defined in the Radiation Safety Act (2016). IHC Mining's analysis of the heavy mineral content within the 1.4 tonne average grade ore sample and the 2.5 tonne high grade sample affirms this. The average grade ore's heavy mineral content contained 128 ± 20 ppm U+Th (approx. 0.5-0.6 Bq/g) as compared to the high grade ore's heavy mineral content at 136 ± 20 ppm U+Th (approx. 0.6-0.7 Bq/g) for the high grade sample.

12 The third HMC sample generated by NZIMMR from a separate sub-set of drill samples also highlights that the natural variability of the HMC will still maintain a very low uranium and thorium decay chain measurement approx. 0.87 Bq/g.

13 Notwithstanding the above, and as mentioned in my 19 January 2024 evidence statement, the during mining and processing of the Barrytown ore, through typical routine analysis of the ore, HMC and reject streams, the Consent Holder will have access to frequent (daily) U+Th assay data, which provides a reliable indicative specific activity value for these streams. This would alert the operation to any unlikely significant spike in HMC radioactivity levels. This data could easily be incorporated into the proposed Conditions of Consent, whereby if the indicative radioactivity value appears elevated to the effect of approaching >1.0 Bq/g based

on U+Th assay, the material would then be sampled and subject to full radiological analysis, additional to the proposed quarterly testing. These daily monitoring records would be required to be made available to the Consent Authority on request, and copies of any independent test results would be required to be submitted to the Consent Authority within 10 working days of receipt of the results.

Concerns regarding the statistical significance of material tested

14 Mr Brian James Lunt and Dr John Philip Bradley raised concerns regarding the statistical sample size (number of samples tested) of material tested, referring to the three samples of HMC submitted for radiological assessment.

15 It is my opinion that these three samples are adequate to conclude that Barrytown HMC is not radioactive due to the scientific method and statistical analysis that drove the selection and generation of these sample. The average grade sample is a spatial composite of 338 of the 1,500 drill samples and the NZIMMR-generated HMC sample was concentrated from a separate sub-set of 111 drill samples. While it is acknowledged that a composite sample could 'mask' spikes in mineralogy of individual 1m interval samples, it is again my understanding that the NZIMMR drill programme did not identify samples with 10-20x increases in radioisotope-bearing mineral (e.g. monazite) concentrations from the average heavy mineral assemblage.

16 The high grade sample extraction location was selected to test the implications of a high grade ore zone on the metallurgical processing. As mentioned in paragraphs 10-11 herein, this sample showed a very high heavy mineral content in the ore, however the heavy mineral content itself was consistent with that of the average grade sample, with respect to radionuclide concentration. It is for this reason that similar HMC qualities were produced between the average grade and the high grade bulk samples.

Concerns regarding airborne radon

17 Dr John Philip Bradley raised concerns regarding the presence of the radioisotope radon. Radon, specifically Rn-222 (or ^{222}Rn), is a decay product of natural uranium. Radon is of particular concern due to its natural state being gaseous and therefore its mobility in air. This is of particular concern in underground mining operations or indoor facilities where ventilation is restricted. The Barrytown Project will be an open cut operation.

18 Acceptable levels of airborne radon above ambient levels are not defined within the Radiation Safety Act (2016). As such, it is responsible to look to international practice, such as the International Atomic Energy Agency "IAEA" Safety Standards No. GSR Part 3. This document sets the appropriate reference level of ^{222}Rn exposure to the public indoors as 300 Bq/m^3".

19 Due to the extremely low levels of uranium in the ore and HMC, Rn-222 levels are expected to remain well below 300 Bq/m^3 and it is my opinion that monitoring for airborne Radon is not required. Notwithstanding this, I have drafted a Consent Condition (Condition 8.9) to incorporate airborne Rn-222 monitoring at the HMC stockpiling building into the proposed radiation monitoring programme for the first year of operation, should the Panel deem this necessary for consent. Radon measurements within the processing plant stockpile building are where the highest readings will be encountered. Therefore, if the processing plant stockpile building readings are below 300 Bq/m^3, levels at the boundary will also comfortably comply.

Concerns regarding the radiological impact of the HMC once removed from site, or during further processing

20 Dr John Philip Bradley raised concerns for the radiological impact of the material once exported, or processed further. As mentioned in my 19 January 2024 evidence statement, all raw ore, reject streams and concentrated HMC within the Barrytown site area are deemed as not radioactive material by the Radiation Safety Act (2016). The HMC is also deemed as non-radioactive and therefore safe for transport by the IAEA Regulations for the Safe Transport of Radioactive Material. No other material is intended to be removed from Barrytown site.

21 It is my understanding that the Applicant intends to export the HMC directly overseas. Once removed from site, the HMC will remain subject to the Radiation Safety Act 2016 and the IAEA Regulations.

Concerns regarding proposed Conditions of Consent with respect to radiation monitoring programme

22 Brian James Lunt raised concerns regarding a lack of detail provided in the Conditions of Consent with regard the planned radiation monitoring mentioned in section 8.0 of the Conditions of Consent.

23 It is my opinion that a detailed radiation monitoring plan is not required due to the sufficient radiological investigations undertaken on the Barrytown material to date, which have consistently shown radiation levels to be well below levels to be considered as radioactive material.

Conclusion

24 The natural variability of the orebody and subsequently the produced HMC are minor and will not cause the material to exceed the 10 Bq/g limit for as stated in the Radiation Safety Act (2016) and the IAEA Regulations for the Safe Transport of Radioactive Material.

25 The NZIMMR drill program and the subsequent bulk material test work conducted by IHC Mining and NZIMMR represent a statistically significant database to

conclude that the Barrytown material, including the produced HMC, lies well below 10 Bq/g limit for as stated in the Radiation Safety Act (2016) and the IAEA Regulations for the Safe Transport of Radioactive Material.

26 Radon levels are expected to be below the safe level of 1,000 Bq/m^3 stipulated by the “IAEA” Safety Standards No. GSR Part 3.

27 Concerns were noted regarding the level of detail and frequency for the proposed radiation monitoring. However, given the sufficient radiological investigations undertaken on the Barrytown material to date, which have consistently shown radiation levels to be well below levels to be considered as radioactive material, it is my opinion that the proposed Conditions of Consent are sufficient. Notwithstanding this, I have proposed a condition requiring additional daily analysis of the HMC from the processed stockpile using a hand-held device.

Mitchell Robert Ryan

Dated this 2nd day of February 2024