HASTINGS
Technology Metals Limited

APPENDIX 7-2

Memo: Radon and Thoron Modelling

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Hastings Yangibana Additional Modelling Memo

Hastings Technology Metals Limited (Hastings) is seeking environmental approvals for the Yangibana Rare Earths Project (YREP). As part of this process, Hastings commissioned Pacific Environment Limited (PEL) to undertake an air quality assessment for the YREP. PEL submitted the final air quality assessment report in November 2016 (PEL, 2016). Further to this, Hastings has requested PEL undertake additional modelling to provide data to support its radiation assessment.

The scope of works involved in the additional modelling is defined below:

- Incorporate two additional discrete receptors and model
  - Monthly dust deposition levels (project only) at the discrete receptors
  - Annual average TSP concentrations (project only) at the discrete receptors
- undertake modelling of Radon and Thoron to predict annual average impact (project only) at the discrete receptors
- a briefing note of the model results

This briefing note details the results of the additional modelling undertaken and should be read in conjunction with the final YREP air quality assessment report (PEL, 2016).

Please don't hesitate to contact me should you have any further queries

Yours sincerely

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1. Introduction

Hastings Technology Metals Limited (Hastings) is seeking environmental approvals for the Yangibana Rare Earths Project (YREP). The project is located approximately 270 kilometres (km) east-northeast of Carnarvon, in the Gascoyne region of Western Australia. The YREP will include open pit mining and processing of mineralised monazite ore, including transport of product to port.

Hastings commissioned Pacific Environment Limited (PEL) to undertake an air quality assessment as part of the process to obtain environmental approval. A final air quality assessment report was submitted by PEL in November 2016 (PEL, 2016). Further to this, Hastings requested PEL undertake additional modelling to provide data to support its radiation assessment. This briefing note presents the summary of additional modelling undertaken, the model results and should be read in conjunction with the YREP air quality assessment report (PEL, 2016).

2. Scope of Works

The scope of works for this briefing note involved the following:

- Incorporate two additional receptors and model
  - Monthly dust deposition levels (project only) at the discrete receptors
  - Annual average TSP concentrations (project only) at the discrete receptors
- undertake modelling of Radon and Thoron to predict annual average impact (project only) at the discrete receptors
- a briefing note of the model results

An outline of the discrete receptors and their locations is presented in Section 3; Section 4 details the dust deposition results while Section 5 presents the results for TSP. A brief of the radiation modelling undertaken and the model results are presented in Section 6. A summary of the results of the additional modelling undertaken are presented in Section 7.

3. Discrete Receptors

The YREP air quality modelling (PEL, 2016) was undertaken to predict impacts at both one discrete receptor (accommodation facility) and a set of uniform gridded recetors (PEL, 2016). As part of this additional modelling, two additional discrete receptors were incorporated: Gifford Creek and Edmund. The locations of the discrete receptors are detailed in Table 3.1 and plotted in Figure 3-1.

Table 3.1: Discrete receptor locations

Receptor ID	Easting (m)	Northing (m)
Gifford Creek	420,600	7,340,300
Edmund	410,370	7,371,700

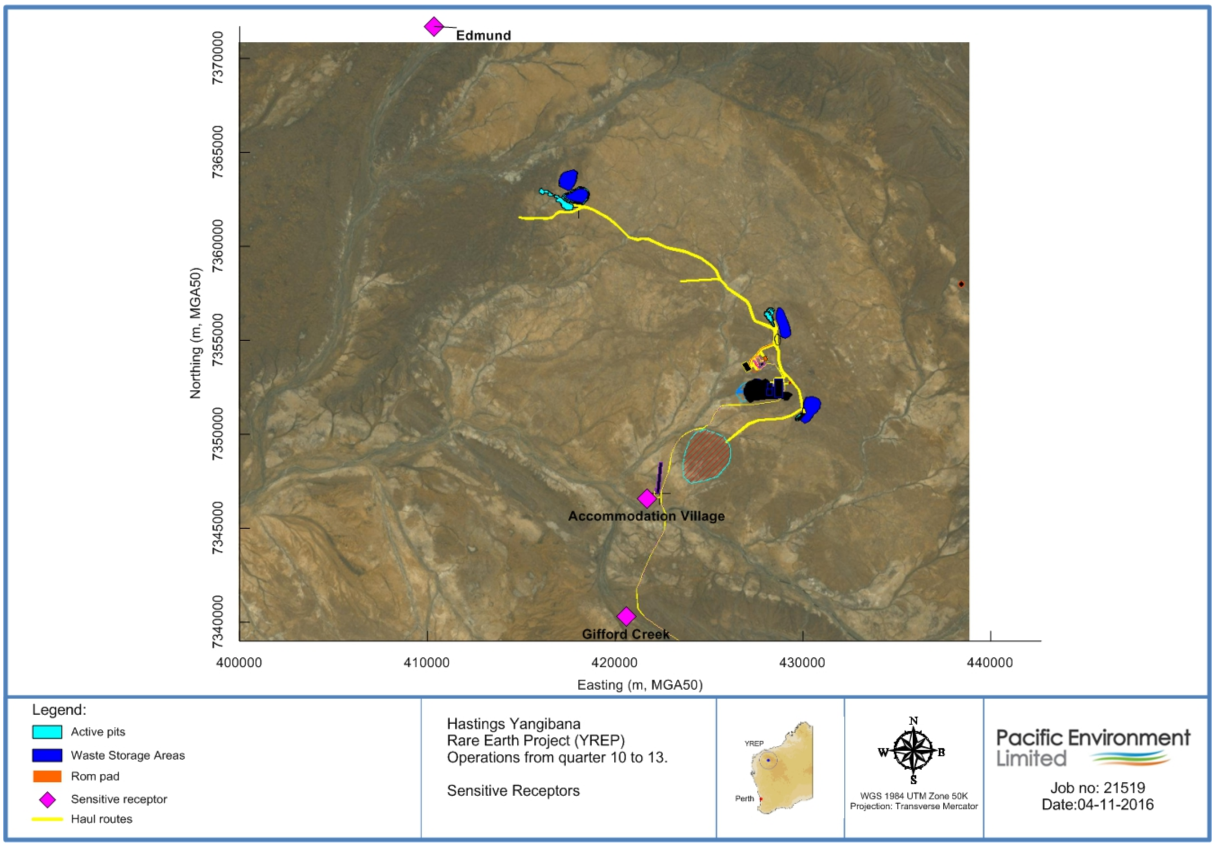

Figure 3-1: Discrete receptor locations

4. Dust Deposition Results

This section presents the results of the maximum monthly dust deposition levels predicted at the discrete receptors. The meteorology, assessment criteria, emission sources and rates, and modelling methodology (including particle size distribution) are detailed in PEL (2016).

It is observed that excluding background (Table 4.1), the maximum monthly dust deposition levels are predicted to occur at the accommodation camp with this less than 0.7% of the NSW DEC criteria.

Table 4.1: Predicted maximum monthly dust deposition levels at the discrete receptors – excluding background

Receptor	Monthly dust deposition (g/m^2/month)
Accommodation Camp	0.014
Gifford Creek	0.002
Edmund	0.007
Criteria	2

5. TSP Results

This section presents the results of the annual average TSP concentrations (Project only) at the discrete receptors. The meteorology, assessment criteria, emission sources and rates, and modelling methodology (including particle size distribution) are detailed in PEL (2016).

It is noted that of the three discrete receptors (Table 5.1), the highest annual average TSP concentrations (excluding background) are predicted to occur at Edmund (0.4$\mu g/m^3$).

Table 5.1: Predicted annual average TSP concentrations at the discrete receptors – excluding background

Receptor	Annual Average TSP ($\mu g/m^3$)
Accommodation Camp	0.30
Gifford Creek	0.16
Edmund	0.40

6. Radiation Modelling

This section provides a summary of the radiation modelling undertaken including a brief on the emission sources, emission rates and modelling methodology. The meteorological data used for this assessment is detailed in PEL (2016). Emissions were modelled as radon (^{222}Rn) and thoron (^{220}Rn) from sources including mining, processing plant, tailing storage facilities and stockpiles. The modelling methodology is described in PEL (2016). Other model parameters including the half-life are detailed in Section 6.2. The model results are presented in Section 6.3.

6.1 Emission Rates & Sources

The radon and thoron emission rates were provided by Hastings and are detailed in Table 6.1. For radon, the top two sources account for 78% of the emissions: stockpiles (42%) and Mining (36%). For thoron, more than half of the emissions are from the hydro plant (58%) followed by stockpiles (20%).

Table 6.1: Radon and Thoron Emission Rates

Source	Emission Rate of Radon (MBq/s)	Emission Rate of Thoron (MBq/s)
Mining	0.13	8.00
Bene Plant	0.02	0.02
Bene Tailings	0.02	5.00
Hydro Plant	0.02	35.00
Hydro Tailings	0.02	0.02
Stockpiles	0.15	12.00
Grand Total	**0.36**	**60.04**

The six sources detailed in Table 6.1 were modelled as area sources in AERMOD with source height set to ground level. The source names and area are presented in Table 6.2.

Table 6.2: Size of radiation sources modelled

Source_ID	Area (m^2)
PAREA1	160,203
PAREA2	121,825
PAREA3	73,439
PAREA4	50,103
PAREA5	36,224
PAREA6	36,650
PAREA7	12,951
PAREA8	13,608

6.2 Modelling methodology

The model set up adopted is as detailed in PEL (2016). Further details on the modelling methodology are presented below

- Both radon and thoron were modelled as gas.
- No deposition was modelled for both radon and thoron.
- Radioactive decay was not modelled for radon as this has little to no effect on the concentrations that can be expected from the modelling domain.
- Thoron was modelled with a half-life of 55.6 seconds or 0.0154 hours.

6.3 Model Results

The annual average concentrations of radon and thoron at the three discrete receptors are presented in Table 6.3. As can be seen from this table, the maximum radon and thoron concentrations are predicted to occur at the accommodation camp (3.1×10^{-3} Bq/m^3 and 1.3×10^{-8} Bq/m^3 respectively). It is predicted that no thoron will be detected at Edmund.

Table 6.3: Predicted annual average radon and thoron concentrations at the discrete receptors – excluding background

Receptor	Radon (Bq/m^3)	Thoron (Bq/m^3)
Accommodation Camp	3.1×10^{-3}	1.3×10^{-8}
Gifford Creek	1.2×10^{-3}	2.0×10^{-11}
Edmund	2.2×10^{-3}	0.0

7. Summary

Hastings commissioned Pacific Environment Limited (PEL) to undertake an air quality assessment as part of the process to obtain environmental approval. A final air quality assessment report was submitted by PEL in November 2016 (PEL, 2016). Further to this, Hastings requested PEL undertake additional modelling to provide data to support its radiation assessment. The additional modelling was undertaken to predict the impact from Project only sources on the monthly dust deposition, annual average TSP and annual average radon and thoron levels at three discrete receptors. The following can be summarised:

- The maximum monthly dust deposition levels are predicted to occur at the accommodation camp with this vale less than 0.7% of the NSW DEC criteria.

- Of the three discrete receptors, the highest annual average TSP concentrations (excluding background) are predicted to occur at Edmund (0.4µg/m^3).
- The maximum radon and thoron concentrations are predicted to occur at the accommodation camp (3.1×10^{-3} Bq/m^3 and 1.3×10^{-8} Bq/m^3 respectively). Due to the extremely small half-life, it is predicted that no thoron will be detected at Edmund.

8. References

PEL (2016). Yangibana Rare Earths Project – Air Quality Assessment, Final Report, 11 November 2016.