Our Ref: D25/3522
Your Ref: L5099/1974/14

11 September 2025

Chief Executive Officer
Department of Water and Environmental Regulation
Locked Bag 33
Cloisters Square, WA, 6850

Dear Chief Executive Officer

**SUBJECT:** TRIAL NOTIFICATION: SOUTHERN PORTS (L5099/1974/14) – BULK IRON SULPHIDE (KALGOORLIE CONSOLIDATED GOLD MINES PTY LTD) VIA ROTATING TIPPING FRAME FROM BERTH 2.

In accordance with Condition 2 of Environmental Licence L5099/1974/14 for Southern Ports (SP) please accept this Trial Notification relating to export shipments of the Iron Sulphide product from Kalgoorlie Consolidated Gold Mines (KCGM).

The Trial will commence on 11/10/2025, 30 days following the submission of this trial notification, and include up to twelve shipments with an average estimate of 5500 tonnes per ship. The Trial will continue for up to 12 months.

Based on the loading controls, product quality and monitoring commitments detailed in Attachment 1, the human health and ecosystem risks will be minimised during the trial shipments and well below acceptable standards. The proposed handling will contain controls over and above the minimum required for these products according to the hazards identified in the product quality testing. Further, SP is already conducting the key monitoring required to support this trial under its existing licence. Both SP and KCGM are committed to continual improvement and the trial outcomes will be assessed and reported towards a formal licence amendment.

The Iron Sulphide proposed for the Trial are compliant with the criteria listed under Condition 5 of Environmental Licence L5099/1974/14, summary below.

| Condition 5 of Environmental Licence L5099/1974/14 | Laboratory Testing results |
|---|---|
| | Kaolin Ore |
| *(a) Contain asbestos in concentrations equal to or greater than 0.01% w/w for nonfriable asbestos or 0.01% w/w for fibrous asbestos;* | No asbestos detected |
| *(b) Contain respirable silica equal to or greater than 1% w/w;* | PM4 is 0.317% (a-quartz) |
| *(c) Exceed the radiation transport limit of 10 Bq/g for Uranium-238 and Thorium232 combined;* | <0.12 (U) + 0.10 (Th) Bq/g |
| *(d) Exceed Rubidium-87 concentrations of 30 Bq/g; or* | 0.014 Bq/g |
| *(e) Are a waste or waste-derived byproduct (except Clean fill).* | No |

In support of this Notification and for your information please find additional information in Attachment 1 (Trial Notification Matrix) and the remaining Attachments which include NATA accredited laboratory testing and analysis of the products.

We look forward to your response, if you require further information, please don't hesitate to contact Alex Leonard on 9072 3388 or 0429 073 546.

Yours sincerely

[redacted]

Interim General Manager Port of Esperance

**Southern Ports**

# Trial Notification Information: Summary of Health and Environmental Risks exporting Iron Sulphide Concentrate via Rotating Tipping Frame at Berth 2 Port of Esperance

| | |
|---|---|
| **Description of proposed Trial** | Iron Sulphide Concentrate is sourced from Kalgoorlie Consolidated Gold Mines located in Kalgoorlie-Boulder, operated by Kalgoorlie Consolidated Gold Mines Pty Ltd.<br><br>The Iron Sulphide Concentrate will be delivered to the Port in half-height containers to be stored onsite prior to shiploading. The product will be loaded into the vessel at Berth 2 via the Container Crane installed with the Rotating Tipping Frame (RTF) emptying the containers into the vessels holds.<br><br>The Trial is expected to commence on 11/10/2025 for approximately 12 to 20 shipments of up to 5,500 Tonnes of Iron Sulphide Concentrate per shipment. |
| **Human health hazards associated with the Trial material** | Laboratory analysis was undertaken to assess the Iron Sulphide Concentrate for HSE classifications according to UN GHS, DG and IMO MARPOL classifications. A HSE Classification Report and a Self-Assessment Report are provided in Attachment 1 and 2 which details the results of the sampling and analysis and the subsequent classification of the product.<br><br>The product is suitable for assessment using the Self-Assessment Decision-Making Flow Chart for trial shipment notification since the product:<br>• The respirable quartz (respirable crystalline silica) content <1% (0.317%) (Attachment 3).<br>• No asbestos fibres are present (Attachment 4).<br>• Radioactivity does not exceed the radiation transport limit of 10 Bq/g for Uranium-238 and Thorium232 combined:<br>  ○ U-238 <0.12 Bq/g<br>  ○ Th-232 0.10 Bq/g<br>• Radioactivity does not exceed Rubidium-87 concentrations of 30Bq/g:<br>  ○ Rb-87 0.014Bq/g. (Attachment 5).<br>• Not classified as a Dangerous Good.<br>• Is not a waste or waste-derived product. |
| **Environmental hazards associated with the Trial material** | Potential hazards include:<br>• Dust emissions to the surrounding community.<br><br>Hazards that are unlikely include:<br>• Odour as the product is odourless (Attachment 6)<br>• Noise as existing RTF operations at the Port of Esperance for other metal concentrates are compliant with the Ports' Regulation 17 noise criteria. |

**Trial Notification Information: Summary of Health and Environmental Risks exporting Iron Sulphide Concentrate via Rotating Tipping Frame at Berth 2 Port of Esperance**

| | |
|---|---|
| | • Impacts to marine biota from stormwater discharge due to concentrations of metals meeting acceptable stormwater targets and minimal spillage associated with the RTF loading (Attachment 1 and 7). |
| **Key human health and environmental risks associated with handling the trial material** | The product contains 0.317% respirable silica quartz, above the Safe Work Australia's Hazardous Chemical Information System (HCIS) criteria of less than or equal to 0.1% (classified as hazardous for carcinogenicity category 1A with the accompanying hazard statement H350i -May cause cancer by inhalation). The iron sulphide product will contain other respirable particulates as 12.5% of its particles are below 10um. |
| **Description of all sensitive receptors, including location and distance from source of hazard** | Loading iron sulphide concentrate by RTF constitutes a prescribed activity and is approximately 290m from the closest residential receptor.<br><br>The harbour waters adjacent to Berth 2 is a modified marine environment but represents a sensitive receptor. |
| **Description of receptor pathways** | The main receptor pathways are via:<br><br>1. airborne dust to the surrounding community<br>2. noise to the surrounding community and<br>3. via stormwater run-off mobilising spilt product to the marine environment. |
| **Description of appropriate handling methods and controls on hazard source for mitigating (and/or minimising) risks to receptors – as determined by self-assessment framework provided by DWER** | The Self-Assessment Decision Making Flow Chart for Trial Products indicates the Minimum Handling Method 3 is suitable for the product, however, Minimum Handling Method 4 will be used (loading: containers emptied into vessels using RTFs). Therefore, the level of handling controls will exceed the minimum requirements.<br><br>The unloading operations will use effective controls including but not limited to:<br>• The product quality of the Iron Sulphide Concentrate will be monitored to ensure it is acceptable for shiploading using an RTF including:<br>  ○ Weekly moisture testing of a representative number of containers before they leave the minesite and comparison against the Dust Extinction Moisture (DEM) (determined by a laboratory to be 1.53% (Attachment 8) to ensure the product does not generate dust as per Licence condition for existing copper and nickel concentrate exports (Condition 14 Table 2 Row 1).<br>  ○ Quarterly Respirable Crystalline Silica monitoring (in accordance with Condition 18 Table 3 Row 3 for existing spodumene exports). |

**Trial Notification Information: Summary of Health and Environmental Risks exporting Iron Sulphide Concentrate via Rotating Tipping Frame at Berth 2 Port of Esperance**

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| | • The product will be completely contained until the containers are lowered into the ships hold when the lid is automatically removed and the container inverted by the RTF to allow the product to slide out into the hold.<br>• Misting sprays will be installed at the top of the ship's hold and turned on if dust is visible.<br>• Competent operators<br>• A spill plate between the hopper and ship.<br>• Any spills are recovered as soon as practical and before rain or at the next hatch change.<br>• All berth washwater and stormwater run-off from the front of the berth during loading is pumped to a water tank and taken to the onsite Waste Water Treatment Plant to remove particulates.<br>• First flush stormwater from the back of the berth flows into a stormwater filtration system (200m3 First Flush Tank and StormDMT filtration) on Berth 2 that reduces concentrations of metals. The water is tested for acceptability for metals including copper and nickel levels before being released into the marine environment.<br>• Strict industrial hygiene and the Berth 2 Storm DMT filtration system will capture any potential particulates in storm run-off.<br>• The proposed dust management triggers reduce the risks to the community and the marine environment to acceptable levels.<br>• Esamplers within the Port measuring 10 minute data on dust levels will send text messages to Terminal Operators to investigate dust if above management triggers.<br>• If visible dust escapes the Port boundary handling activities will be shut down. |
| **Description of proposed monitoring for Trial period** | Monitoring to be conducted as per existing licence conditions:<br>• Condition 14 Table 2 Row 1 to be applied for moisture testing of containers (as for Ni/Cu containers for RTF)<br>• Condition 18 Table 3 Row 3 to be applied for quarterly RCS testing (as for spodumene)<br>• Condition 26 Table 5 Boundary Iron PM10 particle and PM10 monitoring at Sites 1-4<br>• Condition 27: Ensure any reportable event for PM10 is reported as required.<br>• Condition 34: Relating to meteorological monitoring.<br><br>In addition:<br>• Four E-samplers to monitor onsite (near source) dust emissions will be used to provide 10-minute PM10 data during each shipment.<br>• Reporting will occur as required by Condition 6 and include any incidents/complaints or non-material procedural changes.<br>• An application for a formal licence amendment will also depend on whether there will be ongoing trade and may be submitted 3 months prior to the end of the trial. |
| **Description of proposed contingency** | Road sweepers will be used to remove spilt material from hardstand surfaces during shiploading and for berth cleaning following the completion of shiploading. All spilt material will be removed from the premises. |

**Trial Notification Information: Summary of Health and Environmental Risks exporting Iron Sulphide Concentrate via Rotating Tipping Frame at Berth 2 Port of Esperance**

| | |
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| **measures/management actions in the event of unexpected / unplanned incident resulting from Trial** | 1. In the unlikely event that dust is an issue, dust management triggers used for other products loaded via RTF will apply, which include:<br>• If visible dust is observed escaping the hatch, dust mitigation measures will be implemented, including turning on the misting sprays, monitoring of wind speed, wind direction, discharge height from the RTF and loading rate.<br>• Loading will be shut down if dust emissions are identified as an issue by the dust monitoring network located around the port or if dust is visible from Port Beach.<br>2. In the unlikely event that noise is identified as an issue through complaints received or via assessment of continuous monitoring information from the noise logger, an investigation and remedial action will be triggered. Including potential shutdown of operations.<br>3. In the unlikely event of stormwater becoming contaminated in the First Flush Tank, it will either be recirculated through the filter until concentrations of contaminants are acceptable, or the water in the tank treated by other means or removed, transported and disposed as controlled waste. |

# REPORT

## Northern Star Resources Ltd

Hazard Classification of Pyrrhotite Flotation Concentrate for Transport by Road and Rail and Sea

**Date Issued**: 10/12/2024

**Version:** Final Report

Davoren Environmental Pty Ltd

ABN 93 610 442 076

DAVOREN ENVIRONMENTAL

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*Table i Document Control for Report 24NST-004*

| Report Version | Report Type | Date Issued | Prepared By |
|---|---|---|---|
| R0 | Draft | 25.11.2024 | [redacted] |
| R1 | Final | 10.12.2024 | |

[redacted]

Principal Consultant & Director
Davoren Environmental Pty Ltd.

# EXECUTIVE SUMMARY

Northern Star Resources Ltd engaged Davoren Environmental to conduct a hazard assessment of the Pyrrhotite Flotation Concentrate. The purpose of this assessment was to ensure compliance with the following applicable transport regulations:

- Australian (ADG) and International Maritime Dangerous Goods (IMDG) Codes
- International Maritime Solid Bulk Cargoes (IMSBC) Code – Materials Hazardous only in Bulk (MHB) criteria
- MARPOL Annex V – Harmful to the Marine Environment (HME) criteria

A comprehensive test suite to assess applicable Dangerous Goods (DG), MHB, and HME hazards was conducted on the concentrate following the United Nations Manual of Tests and Criteria. Based on these test results, the Pyrrhotite Flotation Concentrate was classified for transport as follows:

- Non-Dangerous Goods under the ADG and IMDG Codes; and
- A Group A but not a Group B cargo (did not meet MHB criteria specified in Section 9.2.3 of the IMSBC Code); and
- Not Harmful to the Marine Environment (not-HME) under MARPOL Annex V

The transport classification of the Pyrrhotite Flotation Concentrate is summarised in Table 1.

*Table 1 Transport classification summary for Pyrrhotite Flotation Concentrate*

| Transport Code | Material Covered | Classification |
|---|---|---|
| **Dangerous Goods (ADG and IMDG)** | Packaged Goods | Non-Dangerous Goods |
| **IMSBC Code** | Solid Bulk Cargoes | Group A[1] |
| **MARPOL Annex V** | Residues of Solid Bulk Cargoes | Not HME |

[1] The Pyrrhotite Flotation Concentrate is classified as a Group A cargo (may liquefy). If shipping the concentrate as a solid bulk cargo the shipper shall be responsible for ensuring a test to determine the Transportable Moisture Limit (TML) is conducted within six months to the date of loading of the cargo.

# GLOSSARY

| | |
|---|---|
| ADG: | Australian Dangerous Goods Code |
| CB: | Combustible solids |
| CR: | Corrosive solids |
| DG: | Dangerous Goods |
| EHS: | Environmentally Hazardous Substance |
| GHS: | Globally Harmonised System of Classification and Labelling of Chemicals |
| HCIS: | Hazardous Chemical Information System |
| HME: | Harmful to the Marine Environment |
| HRL: | HRL Technology Group Pty Ltd |
| IMDG: | International Maritime Dangerous Goods Code |
| IMO: | International Maritime Organisation |
| IMSBC: | International Maritime Solid Bulk Cargoes Code |
| KCGM: | Kalgoorlie Consolidated Gold Mines |
| MEPC: | Marine Environment Protection Committee |
| MHB: | Materials Hazardous only in Bulk |
| NATA: | National Association of Testing Authorities |
| NTC: | National Transport Commission |
| OH: | Other Hazards |
| PSD: | Particle Size Distribution |
| QXRD: | Quantitative X-ray Diffraction |
| RCS: | Respirable Crystalline Silica |
| SDS: | Safety Data Sheet |
| SH: | Self-heating solids |
| STOT-RE: | Specific Target Organ Toxicity - Repeated Exposure |
| STOT-SE: | Specific Target Organ Toxicity - Single Exposure |
| SWFF: | Size Weighted Fine Fraction |
| SWFFcs: | Size Weighted Fine Fraction, crystalline silica |
| TML: | Transportable Moisture Limit |
| TX: | Toxic solids |
| WF: | Solids that evolve flammable gas when wet |
| WT: | Solids that evolve toxic gas when wet |

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# 1 INTRODUCTION

Northern Star Resources Ltd engaged Davoren Environmental to conduct a hazard assessment of a Pyrrhotite Flotation Concentrate. This assessment aimed to classify this material and ensure compliance with applicable transport regulations. Further background information on relevant transport Codes is provided in Appendix 1.

# 2 TESTING OF PYRRHOTITE FLOTATION CONCENTRATE FOR HAZARD ASSESSMENT

To enable the hazard classification of the Pyrrhotite Flotation Concentrate for transport classification, appropriate testing was required to address the numerous physical, health and environmental hazard endpoints specified in the relevant transport regulations. The applicable tests, test endpoints are outlined in Table 2. The laboratory test reports on which the classification of the concentrate was based are referenced in the report and provided separately.

Chemical analysis and testing for Dangerous Goods (DG) and MHB hazards was conducted by HRL[2]. The test methods prescribed in the United Nations Manual of Tests and Criteria for determining the flammability, self-heating, gas evolution, and corrosivity of the concentrate were employed for DG assessment and evaluation of analogous MHB endpoints (United Nations, 2019). Assessment for classification against the MHB criteria was made according to the requirements set out in Section 9.2.3 of the IMSBC Code (IMO, 2023). The mineralogy of the concentrate was confirmed by quantitative X-ray Diffraction (QXRD) by McKnight Mineralogy. ATC Williams Pty Ltd conducted laboratory testing to determine the Transportable Moisture Limit (TML) and bulk density of the concentrate, and these results are summarised in Appendix 2.

[2] HRL Technology Group Pty Ltd, NATA Accreditation No. 561, Site No. 14658.

*Table 2 Test work conducted on Pyrrhotite Flotation Concentrate for hazard assessment under applicable transport codes*

| Hazard | Classification Criteria | Recommended Test |
|---|---|---|
| **ADG and IMDG Code** | | |
| **Classes 1 – 3, and 5, 7** | Material is not<br>• Explosive<br>• A Gas<br>• A Liquid<br>• Oxidising<br>• Radioactive | No testing was required based on relevant product information and physicochemical properties. |
| **Class 4** | Division 4.1 Flammable solids | Manual of Tests and Criteria, part III, sub-section 33.2.4 Test N.1 |
| | Division 4.2 Substances liable to spontaneous combustion | Manual of Tests and Criteria, part III, 33.4.6 Test N.4 |
| | Division 4.3 Water-reactive substances | Manual of Tests and Criteria, part III, 33.5.4 Test N.5 |
| **Class 6.1** | Toxic Substance | Multi-elemental analysis and QXRD[3] |
| **Class 8** | Corrosive Substances | Multi-elemental analysis and QXRD, Manual of Tests and Criteria, part III, section 37 Test C.1. and following Section 9.2.3.7.3 of IMSBC Code |
| | Environmentally Hazardous Substance (EHS) | Multi-elemental analysis and QXRD |
| **Bulk Solid Cargo - IMSBC Code, Materials Hazardous only in Bulk (MHB)** | | |
| **MHB (CB)** | Combustible Solids | Manual of Tests and Criteria, part III, sub-section 33.2.4 Test N.1 and Section 9.2.3.2 (CB) criteria of IMSBC Code |
| **MHB (SH)** | Self-heating Solids | Manual of Tests and Criteria, part III, 33.4.6 Test N.4 and Section 9.2.3.3 (SH) criteria of IMSBC Code |
| **MHB (WF)** | Solids that evolve into flammable gas when wet | Manual of Tests and Criteria, part III, 33.5.4 Test N.5 and Section 9.2.3.4 (WF) of IMSBC Code |
| **MHB (WT)** | Solids that evolve into toxic gas when wet | Manual of Tests and Criteria, part III, 33.5.4 *Test N.5* and Section 9.2.3.5 (WT) criteria of IMSBC Code |
| **Toxic Solids MHB (TX)** | Acute Toxicity-Inhalation 4 | Multi-elemental analysis and QXRD |
| | STOT-SE/STOT-RE–Inhalation 1 | Multi-elemental analysis, QXRD and SWFF calculation[4] |
| | Acute Toxicity-Dermal 4 | Multi-elemental analysis and QXRD |
| | STOT-SE/STOT-RE–Dermal 1 | Multi-elemental analysis and QXRD |
| | Carcinogenicity, Mutagenicity, Reprotoxicity 1A, and 1B | Multi-elemental analysis, QXRD |
| **Corrosive Solids MHB (CR)** | Respiratory Sensitiser 1 | Multi-elemental analysis and QXRD |
| | Skin Corrosion/Irritation 2 | Multi-elemental analysis and QXRD |
| | Eye damage/Irritation 1 or 2A | Multi-elemental analysis and QXRD |
| | Corrosion to metals | Manual of Tests and Criteria, part III, section 37 Test C.1. and Section |

[3] Quantitative X-ray Diffraction (QXRD) to confirm the mineralogy of the sample.
[4] SWFF- Size Weighted Fine Fraction

| | | |
|---|---|---|
| | | 9.2.3.7.3 (CR) of IMSBC Code and IMO MSC.1/Circ.1600/Rev1 |
| **Bulk Solid Cargo (Residues) - MARPOL Annex V (HME)** | | |
| **Environmental and Human Health Criteria** | Acute Aquatic Toxicity Category 1 | Multi-elemental analysis and QXRD |
| | Chronic Aquatic Toxicity Category 1 or 2 | Multi-elemental analysis and QXRD |
| | Carcinogenicity 1A or 1B | Multi-elemental analysis and QXRD |
| | Mutagenicity Category 1A or 1B | Multi-elemental analysis and QXRD |
| | Reproductive Toxicity Category 1A or 1B | Multi-elemental analysis and QXRD |
| | STOT-RE Category 1 | Multi-elemental analysis and QXRD |
| | Synthetic polymer, rubber, or plastic | Not relevant to this material. No testing required |

# 3 RESULTS

HRL received the sample identified as Pyrrhotite Flotation Concentrate on 7 November 2024. The moisture content of the received sample was confirmed as 10.3 per cent. The laboratory report was issued on 21 November 2024 (HRL Technology Group Pty Ltd, 2024). Details of the received sample are provided in Appendix 3.

## 3.1 Particle Size Distribution

Particle Size Distribution (PSD) data is presented in Table 3. The data confirmed that approximately 92 per cent of particles in the Pyrrhotite Flotation Concentrate were sized below 100 µm. Particle size is an important parameter in consideration for environmental and human exposures. The larger the particle size, the less likely that the particle is mobile in the environment through air and water or inhaled by people. Particles 100 µm or larger are not typically drawn into the body by inhalation because of their size. Relative to total airborne particles, the particle size having 50 per cent penetration for the thoracic (i.e., inhaled particles penetrating beyond the larynx) and respirable (i.e., inhaled particles penetrating to the unciliated airways) fractions in terms of aerodynamic diameter are ≤ 10 µm and ≤ 4.0 µm respectively (Brown, Gordon, Price, & Asgharian, 2013).

*Table 3 Particle size distribution (% w/w) of the Pyrrhotite Flotation Concentrate*

| Particle size µm | Pyrrhotite Flotation Concentrate |
|---|---|
| > 1000 | 0.0 |
| 1000 - 500 | 0.2 |
| 500 – 250 | 1.5 |
| 250 - 100 | 6.1 |
| 100 - 45 | 16.8 |
| 45-10 | 50.4 |
| ≤ 10 | 25.0 |

## 3.2 Chemical Characterisation

### 3.2.1 Elemental Analysis

A subsample was ground to a top size of nominally 100 µm before analysis. The concentration of 41 elements is reported in Table 4. The main elements (> 1%) are shown in Figure 1 and were reported approximately as iron (Fe) and sulphur (S) at 36 per cent, silicon (Si) at 6 per cent, aluminium at 2 per cent and calcium at 1 per cent.

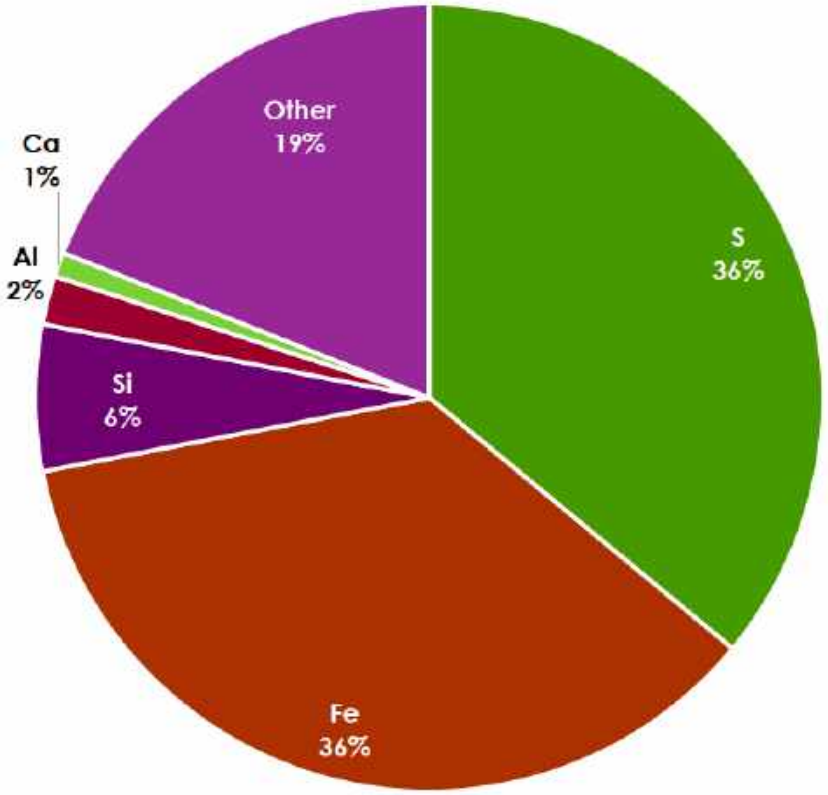


*Figure 1 Main elements (> 1%, approximate) in the Pyrrhotite Flotation Concentrate confirmed by elemental analysis (Table 4).*

*Table 4 Concentration of elements in the Pyrrhotite Flotation Concentrate*

| Element | Detection Limit | Unit | Concentration |
|---|---|---|---|
| Ag | 0.10 | mg/kg (dry basis) | 31.00 |
| Al | 10.00 | mg/kg (dry basis) | 16356.00 |
| As | 4.00 | mg/kg (dry basis) | 1544.00 |
| Au | 1.00 | mg/kg (dry basis) | 44.00 |
| B | 0.20 | mg/kg (dry basis) | 12.00 |
| Ba | 0.60 | mg/kg (dry basis) | 57.00 |
| Be | 0.10 | mg/kg (dry basis) | 0.40 |
| Bi | 0.50 | mg/kg (dry basis) | 13.00 |
| Total C | 0.01 | % (dry basis) | 0.93 |
| Total C- inorganic | 0.01 | % (dry basis) | 0.33 |
| Total C - organic | 0.01 | % (dry basis) | 0.60 |
| Ca | 10.00 | mg/kg (dry basis) | 12970.00 |
| Cd | 0.10 | mg/kg (dry basis) | 29.00 |
| Ce | 8.00 | mg/kg (dry basis) | 17.00 |
| Cl | 0.01 | % (dry basis) | 0.63 |
| Co | 1.00 | mg/kg (dry basis) | 646.00 |
| Cr | 1.00 | mg/kg (dry basis) | 309.00 |
| Cu | 5.00 | mg/kg (dry basis) | 2370.00 |
| F | 1.00 | mg/kg (dry basis) | 530.00 |
| Fe | 2.00 | mg/kg (dry basis) | 357150.00 |
| Hg | 0.01 | mg/kg (dry basis) | 18.00 |
| K | 10.00 | mg/kg (dry basis) | 4690.00 |
| Mg | 10.00 | mg/kg (dry basis) | 6262.00 |
| Mn | 10.00 | mg/kg (dry basis) | 947.00 |
| Mo | 0.10 | mg/kg (dry basis) | 23.00 |
| Na | 10.00 | mg/kg (dry basis) | 7300.00 |
| Ni | 0.10 | mg/kg (dry basis) | 468.00 |
| P | 10.00 | mg/kg (dry basis) | 232.00 |
| Pb | 1.00 | mg/kg (dry basis) | 56.00 |
| Pd | 10.00 | mg/kg (dry basis) | <10.00 |
| S | 10.00 | mg/kg (dry basis) | 355850.00 |
| Sb | 0.50 | mg/kg (dry basis) | 137.00 |
| Se | 2.00 | mg/kg (dry basis) | 72.00 |
| Si | 10.00 | mg/kg (dry basis) | 62930.00 |
| Sn | 1.00 | mg/kg (dry basis) | 3.00 |
| Sr | 1.00 | mg/kg (dry basis) | 49.00 |
| Te | 1 | mg/kg (dry basis) | 105.00 |
| Ti | 10.00 | mg/kg (dry basis) | 5820.00 |
| Tl | 1.00 | mg/kg (dry basis) | 19.00 |
| V | 0.20 | mg/kg (dry basis) | 140.00 |
| Zn | 0.20 | mg/kg (dry basis) | 1153.00 |
| Zr | 0.20 | mg/kg (dry basis) | 73.00 |

### 3.2.2 Mineralogy

Quantitative XRD analysis reporting crystalline phases was conducted by McKnight Mineralogy (McKnight Mineralogy, 2024). The analysis confirmed that the predominant mineral in the concentrate was the iron sulphide mineral pyrite. The complete list of mineral phases identified in the Pyrrhotite Flotation Concentrate is shown in Table 5.

*Table 5 QXRD results (wt%) for Pyrrhotite Flotation Concentrate (including amorphous estimate)*

| Phase | wt.% |
|---|---|
| Pyrite ($FeS_2$) | 61.2 |
| Pyrrhotite-4C ($Fe_7S_8$) | 9.7 |
| Muscovite ($KAl_2(Si_3Al)O_{10}(OH)_2$) | 8.6 |
| Quartz ($SiO_2$) | 7.6 |
| Ankerite ($Ca(Fe,Mg,Mn)(CO_3)_2$) | 4.8 |
| Albite ($NaAlSi_3O_8$) | 3.2 |
| Chlorite ($(Mg,Al,Fe)_{12}[(Si,Al)_8O_{20}](OH)_{16}$) | 2.3 |
| Magnetite ($Fe_3O_4$) | 1.6 |
| Chalcopyrite ($CuFeS_2$) | 0.6 |
| Sphalerite ($ZnS$) | 0.2 |
| Talc ($Mg_3Si_4O_{10}(OH)_2$) | 0.2 |
| Amorphous | 0.0 |

### 3.2.3 Respirable Quartz Analysis

Mineralogical analysis (Table 5) confirmed that the Pyrrhotite Flotation Concentrate contained 7.6 per cent crystalline silica (quartz), and the PSD data (Table 3) demonstrated that the concentrate had a significant proportion of finer-sized particles.

Therefore, a calculation method to determine the size weighted relevant fine fraction within the bulk material was applied to the data (Pensis, Luetzenkirchen, & Friede, 2013). Full details on the method are provided in Appendix 4. Based on these calculations, the size-weighted fine fraction in the Pyrrhotite Flotation Concentrate was determined as follows:

- The fine fraction of the concentrate was calculated at 6.5 per cent[5], and the concentration of crystalline silica in the fine fraction was calculated at 0.5 per cent.

[5] This was calculated at the proposed shipping density of 2,470 kg/m³.

## 3.3 Dangerous Goods Test Results

### 3.3.1 Class 4.1 – Flammable Substances

The Pyrrhotite Flotation Concentrate was held in contact with the flame for 2 minutes and was not found to ignite or propagate combustion by burning with flame or smouldering. The concentrate was, therefore, not classified as a Class 4, Division 4.1 flammable solid under the ADG and IMDG Code.

### 3.3.2 Class 4.2 – Self-Heating Substances

Following the prescribed test (Test N.4), a positive result is obtained if spontaneous ignition occurs or if the temperature of the test sample exceeds the oven temperature by 60 °C (i.e. determined to dangerously self-heat) during the 24-hour testing time. Otherwise, the result is considered negative.

The Pyrrhotite Flotation Concentrate was determined not to be dangerously self-heating and was, therefore, not classified as Class 4, Division 4.2 substances liable to spontaneous combustion under the ADG and IMDG Code.

### 3.3.3 Class 4.3 – Substances Which, in Contact with Water, Emit Flammable Gases

There was no spontaneous ignition or evolution of flammable gas at a rate greater than 1 litre per kilogram per hour when the concentrate was in contact with water. When observed over the 24-hour period, the total gas emission rate was below the instrument detection limit (0.014 litres per kilogram per hour). Following the prescribed method, the tested concentrate was not classified as a Class 4, Division 4.3 substance under the ADG and IMDG Code.

### 3.3.4 Class 6.1 Toxic Substances

For the Class 6.1 hazard assessment, the chemical analysis results reported in Tables 4 and 5 for the Pyrrhotite Flotation Concentrate were evaluated using the metals classification tool MeClas to determine if the concentrate met the criteria for classification. The tool uses the most up-to-date information on metal toxicity and bioavailability. Under the ADG and IMDG Code, any substance that meets the acute toxicity criteria (for oral, dermal or inhalation) categories 1 – 3 is classified as DG Class 6.1. The human health hazards were determined following GHS; these results are summarised in Appendix 5. The tested concentrate was not found to meet any acute toxicity criteria and was, therefore, not classified as DG Class 6.1 substances.

### 3.3.5 Class 8 Corrosive Substances

The Pyrrhotite Flotation Concentrate was tested using the refined MHB (CR) method published by the IMO (IMO, 2023). The test was conducted for a 7-day exposure period. The prescribed test recommends that it be performed on representative cargo samples at conditions representing their as-shipped conditions (refer to Table 6).

*Table 6 Test conditions for corrosion test*

| Test Conditions | |
|---|---|
| **Moisture %** | 8[6] |
| **Density kg/m³** | 2470 |
| **Atmosphere** | Closed system |

#### *3.3.5.1 Uniform Corrosion*

The steel coupons were cleaned, rinsed, dried, and weighed after the test was completed. The coupon weight is used to determine the mass loss in grams and as a percentage of the original mass. For the evaluation of uniform corrosion, the test is considered positive if the mass loss on any coupon exceeds the limit specified for the test exposure time. The allowable limit for the 7-day test period is 13.5 per cent. The maximum mass loss recorded due to uniform corrosion was 7.12 per cent, recorded in the buried coupon for the Pyrrhotite Flotation Concentrate.

#### *3.3.5.2 Localised Corrosion*

Localised corrosion is defined as corrosion at discrete sites (e.g. pitting[7]) (ASTM, 2021). Following a visual inspection, no localised corrosion was observed on any of the test coupons. A summary of the corrosion test results is presented in Table 7. pH testing is not a requirement of the DG or MHB criteria, but as changes in pH may influence corrosion rates, the pre-and post-test pH was measured and is also reported in Table 7.

*Table 7 Summary of corrosion test results for the Pyrrhotite Flotation Concentrate*

| Test Criteria | Result |
|---|---|
| **Maximum Mass Loss (%)** | 7.12 |
| **Local Corrosion** | No |
| **pH pre-test** | 7.79 |
| **pH post-test** | 6.69 |

### 3.3.6 Class 9 Environmentally Hazardous Substances

This assessment was based on available chemistry (Tables 4 and 5) and employed the metals classification tool MeClas, which includes several tiers to refine the classification of complex materials. The tool uses the most up-to-date information on metal toxicity and bioavailability. According to the ADG and IMDG Code, substances shall be classified as EHS if they satisfy criteria for acute aquatic toxicity (category 1) and/or chronic aquatic toxicity (category 1 or 2). The Pyrrhotite Flotation Concentrate was classified for acute aquatic toxicity category 2 and chronic aquatic toxicity

[6] Moisture of the received sample was amended to as shipped conditions.
[7] Pitting—localized corrosion of a metal surface that is confined to a small area and takes the form of cavities called pits (ASTM, 2021).

category 3. As the Pyrrhotite Flotation Concentrate did not meet the criteria for classification (i.e. not acute category 1 or chronic category 1 or 2), it was not classified as a Class 9 Substance (EHS) under the ADG and IMDG Codes.

## 3.4 IMSBC (MHB) Test Results

### 3.4.1 Combustible Solids MHB (CB)

The Pyrrhotite Flotation Concentrate did not ignite or propagate combustion by burning with flame or smouldering. The prescribed method did not classify it as combustible solid MHB (CB) under the IMSBC Code.

### 3.4.2 Self-Heating Solids MHB (SH)

Under the IMSBC Code, materials that do not meet the criteria for inclusion in Class 4.2 may be classified as self-heating solids when transported in bulk and are designated as MHB (SH). A material shall be classified as MHB (SH) if the temperature of the test sample rises by more than 10 °C when using a 100 mm cube sample at 140 °C and 100 °C. The concentrate temperature was not recorded to rise 10˚C or more over ambient temperature at any point over the 48-hour test period (a maximum temperature of 146.2 °C was recorded). On this basis and following Section 9.2.3.3 criteria of the IMSBC code, Pyrrhotite Flotation Concentrate was not classified as an MHB (SH).

In addition to the above criteria, a material shall also be classified as MHB (SH) if a temperature rise of 10 °C or more over ambient temperature is observed during any portion of the United Nations Manual of Tests and Criteria, part III, 33.5.4 test (Test N.5/MHB (WF) test refer to Section 3.4.3 of this report). The temperature of the tested concentrate was not recorded to rise 10 °C or more over ambient temperature at any point over the 48-hour test period.

### 3.4.3 Solids that Evolve into Flammable Gas When Wet MHB (WF)

The Pyrrhotite Flotation Concentrate was not found to evolve any gas when tested according to the prescribed method and was, therefore, not classified as a solid that evolves into flammable gases MHB (WF) when wet under the IMSBC Code.

### 3.4.4 Solids that Evolve Toxic Gas When Wet MHB (WT)

The Pyrrhotite Flotation Concentrate was not found to evolve any gas when tested according to the prescribed method and was, therefore, not classified as a solid that evolves toxic gas when wet MHB (WT) under the IMSBC Code.

### 3.4.5 Toxic Solids MHB (TX) Classification

Under the IMSBC Code, only exposures via the inhalation and dermal routes are considered for toxicity classification. The Pyrrhotite Flotation Concentrate was confirmed to contain approximately 8 per cent of crystalline silica (quartz) (refer to

Table 5), of which 0.5 per cent was determined to be respirable (refer to Section 3.2.3 and Appendix 4).

Crystalline silica (fine fraction) is self-classified by the industry (IMA-Europe, 2022) as follows:

- STOT RE 1, if the quartz (fine fraction) or cristobalite (fine fraction) concentration is equal to, or greater than 10%,
- STOT RE 2, if the quartz (fine fraction) or cristobalite (fine fraction) concentration is between 1 and 10% and
- Not classified for STOT hazard if the quartz (fine fraction) or cristobalite (fine fraction) in mixtures and substances is below 1.

Based on these results and following industry self-classification (IMA-Europe, 2022), the Pyrrhotite Flotation Concentrate was not classified for the STOT-RE category hazard as the percentage of quartz (fine fraction) was calculated to be below 1%. The distribution for RCS was therefore amended in MeClas. A material shall be classified as an MHB (TX) if it meets the criteria of STOT-RE Category 1 only. Based on this refinement, the Pyrrhotite Flotation Concentrate was not classified as an MHB (TX).

### 3.4.6 Corrosive Solids MHB (CR) Classification

The criteria for uniform corrosion, as specified in the IMSBC Code, is 4 mm to 6.25 mm a year. The corrosion rates of all steel coupons tested were below these limits for the IMSBC classification. Based on these uniform corrosion results, the Pyrrhotite Flotation Concentrate was not classified as a corrosive solid MHB (CR) under the IMSBC Code. In addition, an inspection of the test coupons confirmed that no localised corrosion was observed.

Based on chemical characterisation results, the Pyrrhotite Flotation Concentrate was not classified for any other corrosive criteria, i.e., Respiratory Sensitisation, Skin Corrosion/Irritation, or serious eye damage/Eye Irritation. Therefore, the concentrate was not classified as an MHB (CR) solid under the IMSBC Code.

## 3.5 MARPOL Annex V Test Results

This assessment for HME hazards (environmental and health criteria) was based on available chemistry (Tables 4 and 5) and employed the metals classification tool MeClas.

### 3.5.1 Classification of Environmental Criteria

In accordance with MARPOL Annex V criteria, a solid bulk cargo shall be classified as HME if it satisfies the criteria for acute aquatic toxicity (category 1) and/or chronic aquatic toxicity (category 1 or 2). The Pyrrhotite Flotation Concentrate did not meet the acute or chronic aquatic toxicity criteria for classification as an HME under MARPOL Annex V (IMO, 2016).

### 3.5.2 Classification of Health Criteria

Only substances categorised for oral or dermal hazards (or without specification of the exposure route in the hazard statement) that also meet the criteria of high bioaccumulation and not being rapidly degradable meet the requirements for classification against MARPOL Annex V criteria.

Residues of solid bulk cargoes are considered HME if the cargoes are classified against any of the seven MARPOL Annex V criteria. The Pyrrhotite Flotation Concentrate did not meet the environmental or health criteria, so it should not be classified as an HME under MARPOL Annex V (IMO, 2016).

# 4 CLASSIFICATION SUMMARY

A Pyrrhotite Flotation Concentrate from Northern Star Resources was tested as part of this assessment. A complete test suite to assess all applicable Dangerous Goods and MHB hazards was conducted on the concentrate in accordance with the United Nations Manual of Tests and Criteria. The human health and environmental hazards of the Pyrrhotite Flotation Concentrate were assessed using chemical characterisation and mineralogical information. This assessment was conducted in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) and employed the metals classification tool MeClas. The resulting hazard assessment is summarised in Appendix 5.

- Non-Dangerous Goods under the ADG and IMDG Code; and
- A Group A but not a Group B cargo under the IMSBC Code; and
- Not Harmful to the Marine Environment (not-HME) under MARPOL Annex V.

Table 8 summarises the transport classification of Pyrrhotite Flotation Concentrate based on the results of relevant tests and subsequent classification against the applicable criteria (as outlined in this report).

*Table 8 Transport classification summary for the Pyrrhotite Flotation Concentrate*

| Transport Code | Relevant Material | Classification |
|---|---|---|
| **Dangerous Goods (IMDG)** | Packaged Goods | Non-Dangerous Goods |
| **IMSBC Code** | Solid Bulk Cargoes | Group A[8] |
| **MARPOL Annex V** | Residues of Solid Bulk Cargoes | Not HME |

[8] Refer to Appendix 2 of this report.

# 5 REFERENCES


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# APPENDIX 1. RELEVANT TRANSPORT LEGISLATION

## Dangerous Goods

Dangerous Goods are classified into nine different classes listed in Table 1A below according to the hazard or the most predominant of the hazards they present.

*Table 1A Dangerous Goods classes*

| Class | Hazard |
|---|---|
| **Class 1** | Explosives |
| **Class 2** | Gases |
| **Class 3** | Flammable liquids |
| **Class 4** | Flammable solids, substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases |
| **Class 5** | Oxidising substances and organic peroxides |
| **Class 6** | Toxic and infectious substances |
| **Class 7** | Radioactive material |
| **Class 8** | Corrosive substances |
| **Class 9** | Miscellaneous dangerous substances and articles (this includes environmentally hazardous substances |

The Australian Dangerous Goods Code (NTC, 2024) and International Maritime Goods Code (IMO, 2022) cover land and maritime transport of packaged goods, respectively.

### *Australian Dangerous Goods (ADG) Code*

The ADG Code sets out the technical requirements for regulating the land transport of Dangerous Goods in Australia. The Department of Infrastructure and Regional Development is responsible for maintaining the ADG as part of an ongoing strategy to align domestic land transport requirements with international requirements for the safe transport of Dangerous Goods. The National Transport Commission (NTC) is an inter-governmental agency created to develop regulatory and operational reform for road, rail, and intermodal transport. As such, the NTC reviews the ADG every two years to help meet international best-practice and evolving user needs in Australia.

The Australian Dangerous Goods Code is updated every two years, with a one-year transition period for each edition. Edition 7.9 is the latest edition of the ADG Code and can be used from 1 October 2024 and is mandatory from 1 October 2025. A 12-month transition period during which compliance can be achieved with either Edition 7.8 or Edition 7.9 may be applied depending on the jurisdiction's readiness to adopt the updated regulations (NTC, 2024).

### *International Maritime Dangerous Goods (IMDG) Code*

The IMDG code was developed to ensure the safe maritime transport of packaged Dangerous Goods, including substances, mixtures, and articles. New amendments to the IMDG Code are published every two years, each valid for up to three years. The IMDG Code, 2022 Edition (incorporating Amendment 41-22) came into force on 1 January 2024 (IMO, 2022).

## International Maritime Solid Bulk Cargoes (IMSBC) Code

The IMSBC Code, adopted on 4 December 2008 by resolution MSC.268(85), entered into force on 1 January 2011, from which date it was made mandatory under the provisions of the SOLAS Convention. The IMSBC Code and Supplement, 2023 Edition, was published in September 2023. This new edition incorporates amendment 07-23 (Resolution MSC.539(107)), which may be applied voluntarily from 1 January 2024 and has an official entry into force on 1 January 2025 (IMO, 2023)[9].

According to code requirements, where a cargo meets one or more of the chemical hazard criteria for classification as Materials Hazardous only in Bulk (MHB), a notational reference for each hazard must be included in the "Class cell" of the characteristics table. A summary of the notational references is presented below in Table 1B.

*Table 1B Summary of Materials Hazardous only in Bulk (MHB) criteria*

| Notational Reference | Chemical Hazard |
|---|---|
| **CB** | Combustible solids |
| **SH** | Self-heating solids |
| **WF** | Solids that evolve flammable gas when wet |
| **WT** | Solids that evolve toxic gas when wet |
| **TX** | Toxic solids |
| **CR** | Corrosive solids |
| **OH** | Other hazards |

## MARPOL ANNEX V

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention governing the prevention of pollution to the marine environment by ships from operational or accidental causes. The MARPOL convention was adopted in 1973, whereas the actual protocol was adopted in 1978. The combined instrument MARPOL 73/78 entered force in 1983 and has been subject to amendments over the years. In July 2011, the International Maritime Organization (IMO) adopted revisions to MARPOL Annex V that were relevant to the transport of solid bulk cargoes. Under MARPOL Annex V, the management of the residues of solid bulk cargoes depends primarily on the classification of the solid bulk cargo as to

[9] The IMSBC Code 2022 Edition incorporating the 6th Amendment is still valid until 31 December 2024.

whether it is Harmful to the Marine Environment (HME) or not-HME. In 2017, the Marine Environment Protection Committee (MEPC) of IMO adopted the 2017 Guidelines for the implementation of MARPOL Annex V (resolution MEPC.295(71)) to assist in the implementation of requirements for MARPOL Annex V as amended by Resolution MEPC.277(70) which was adopted in 2016 and came into force on 1 March 2018 (IMO, 2016).

Cargo residues are considered HME if they are classified against any one of the following seven parameters according to the GHS.

1. Acute Aquatic Toxicity, Category 1; and/or
2. Chronic Aquatic Toxicity, Category 1 or 2; and/or
3. Carcinogenicity[10] 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or
4. Mutagenicity[10] 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or
5. Reproductive Toxicity[10]1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or
6. Specific Target Organ Toxicity-Repeated Exposure[10] (STOT-RE) Category 1 combined with not being rapidly degradable and having high bioaccumulation; and/or
7. Solid bulk cargoes containing or consisting of synthetic polymers, rubber, plastics, or plastic feedstock pellets (this includes materials that are shredded, milled, chopped, or macerated or similar materials).

## United Nations Globally Harmonized System of Classification and Labelling of Chemicals

The GHS system is used to classify and communicate chemical hazards using internationally consistent terms and information on chemical labels and SDS. The first edition of the GHS, intended to serve as the initial basis for the global implementation of the system, was adopted in December 2002 and published in 2003. Since then, the GHS has been updated, revised, and improved every two years as needs arise and experience is gained in its implementation. Different regulations may use different editions of the GHS. SDS are prepared in Australia following the seventh revised edition as modified under Schedule 6 of the Model Work Health and Safety Regulations[11]. The ninth revised edition of the GHS is the version to which the IMSBC 2023 and IMDG 2022 editions are aligned and the latest edition of the ADG Code applies the tenth revised edition of the GHS.

[10] Products that are classified for Carcinogenicity, Mutagenicity, Reproductive toxicity, or Specific Target Organ Toxicity Repeated Exposure for oral and dermal hazards or without specification of the exposure route in the hazard assessment.
[11] www.safeworkaustralia.gov.au/doc/model-whs-regulations

# APPENDIX 2. TML AND CARGO CHARACTERISTICS

The Pyrrhotite Flotation Concentrate is classified as a Group A cargo[12]. Testing was therefore conducted by ATC Williams Pty Ltd to determine its TML[13] and bulk and dry density. The results of this testing are presented below in Table 2A.

*Table 2A Summary of TML and density test results for the Pyrrhotite Flotation Concentrate*

| Test | | Result | Reference |
|---|---|---|---|
| TML (%) by Flow Table | | 9.0 | (ATC Williams Pty Ltd, 2024a) |
| Angle of Repose ° | Survey test | 36.5 | (ATC Williams Pty Ltd, 2024b) |
| | Tilting box test | 39.5 | |
| Uncompacted Bulk Density kg/m³ | Bulk density (As received water content) | 1,493 | (ATC Williams Pty Ltd, 2024c) |
| | Dry density | 1,347 | |
| Compacted Bulk Density kg/m³ | Bulk density (As received water content) | 2,873 | |
| | Dry density | 2,592 | |
| As received (Gross) Water Content (%) | | 9.8 | |

[12] Group A consists of cargoes which possess a hazard due to moisture that may result in liquefaction or dynamic separation if shipped at a moisture content in excess of their transportable moisture limit.

[13] Note it is mandatory provision that the shipper shall be responsible for ensuring a test to determine the TML of a solid bulk cargo is conducted within six months to the date of loading of the cargo (refer Section 4.5.1 of the IMSBC Code).

# APPENDIX 3. PYRRHOTITE FLOTATION CONCENTRATE

A photo of the sample received at HRL on 07 November 2024 is shown below in Figure 3A. The Pyrrhotite Flotation Concentrate was described as an olive-green material with silver specks. The as-received moisture content was determined as 10.3 per cent.


*Figure 3A Pyrrhotite Flotation Concentrate received at HRL on 7 November 2024*

# APPENDIX 4. SIZE WEIGHTED RELEVANT FINE FRACTION (SWFF) OF CRYSTALLINE SILICA

Mineralogical analysis conducted by McKnight Mineralogy reported quartz concentration of 7.6 per cent. A method has been developed in the industrial minerals industry to determine the "size weighted relevant fine fraction" within the bulk material. It has previously been used in the industry and by institutes under the acronym SWeRF (Pensis, Luetzenkirchen, & Friede, 2013). The "size weighted fine fraction" (SWFF) method only measures the fraction of the substance (e.g. fine dust or fine crystalline silica) present in the material. The method was standardised in 2020 through CEN (the European Committee for Standardisation)[14]. The method is specifically for bulk materials and, does not estimate occupational exposure to hazardous substances, and is not a substitute for workplace measurements. The primary purpose is to determine the potential respirable fraction for classification and labelling purposes (IMA-Europe, 2022).

The principle behind the SWFF method is to combine the size of a particle with its probability of entering the lungs' unciliated airways, as described in the EN 481 standard (CEN, 1993). The SWFF is a fraction of a material in which the contribution of each particle is weighted as a function of its size. SWFF is thus a method to predict how particles in a bulk material would move when they become airborne and are inhaled.

There are two ways to determine the SWFF of a material – calculation or sedimentation. For the calculation method, the PSD of the material is determined, and the SWFF is then calculated from this PSD using the probability function of EN 481. To facilitate the use of SWFF, IMA - Europe has made available a SWFF calculation spreadsheet and guide (IMA-Europe, 2020). The SWFF (of the total sample) is calculated based on the PSD and the density of the sample. The SWFFcs (the SWFF of the crystalline silica (CS) in the sample) are calculated using the PSD of the sample, the density of the CS, and the content of CS determined in the sample. The PSD data reported by HRL and the reported shipping bulk density were used. The density of CS was entered as 2650 kg/m$^3$. The SWFF calculation spreadsheet is provided separately to this report. A summary of the results is provided in Table 4A and an excerpt of the SWFF report is shown in Figure 4A. The green curve (SWFF) represents the fine fraction in the sample calculated according to EN 481.

Based on these results the Pyrrhotite Flotation Concentrate was calculated to have a fine fraction (SWFF) of 6.5 per cent and the crystalline silica in the fine fraction was calculated at 0.5 per cent.

[14] EN 17289-1:2020 Characterization of bulk materials - Determination of a size-weighted fine fraction and crystalline silica content - Part 1: General information and choice of test methods.

*Table 4A Calculation of size weighted relevant fine fraction (SWFF) of crystalline silica (CS) in the Pyrrhotite Flotation Concentrate*

| Parameter | Result |
|---|---|
| CS (%)[15] | 7.6 |
| Bulk Density (kg/m³) | 2470 |
| SWFF (%) | 6.5 |
| SWFFcs (%) | 0.5 |

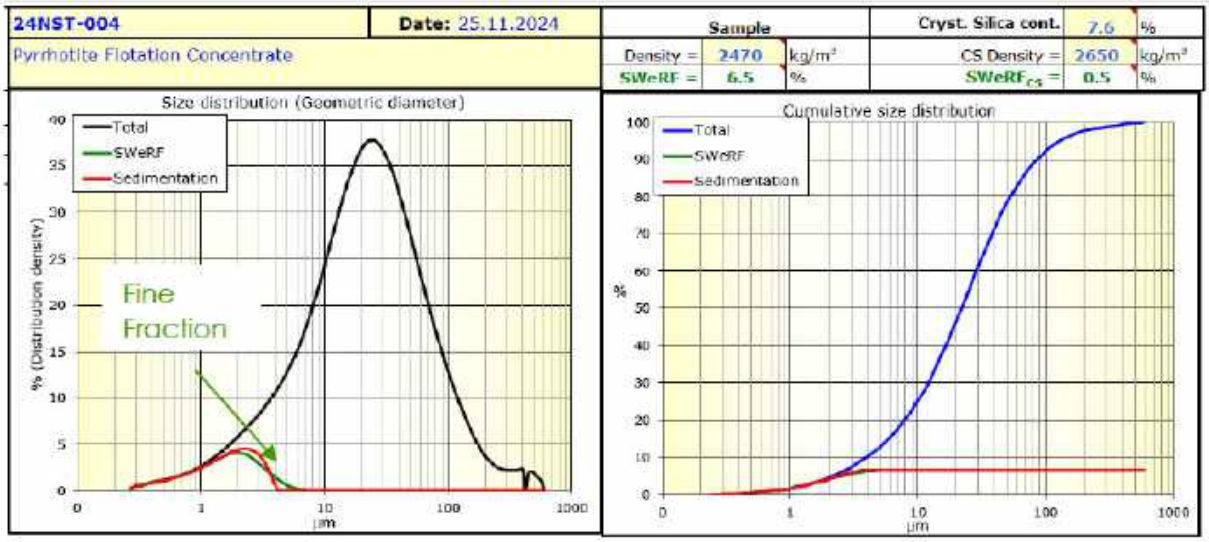


*Figure 4A Excerpt from SWFF calculation report showing size distribution plot for the Pyrrhotite Flotation Concentrate*

[15] CS: Crystalline Silica – This was confirmed by QXRD analysis (McKnight Mineralogy, 2024).

# APPENDIX 5. GHS CLASSIFICATION

The classification derived using the metals classification tool MECLAS version 5.14 http://www.meclas.eu is shown in Table 5A. A hazard assessment was conducted using elemental (refer to Table 4) and mineralogical analysis (refer to Table 5).

*Table 5A GHS Classification for health and environmental hazards for Pyrrhotite Flotation Concentrate based on chemical analysis results*

| GHS Hazard Endpoint | Classification |
|---|---|
| Acute toxicity-oral | Not classified |
| Acute toxicity-dermal | Not classified |
| Acute toxicity-inhalation | Not classified |
| Skin corrosion/irritation | Not classified |
| Serious eye damage/eye irritation | Not classified |
| Respiratory or skin sensitisation | Not classified |
| Germ cell mutagenicity | Not classified |
| Carcinogenicity[16] | Not classified |
| Reproductive toxicity | Not classified |
| Specific target organ toxicity - single exposure | Not classified |
| Specific target organ toxicity - repeated exposure | Not classified |
| Aspiration hazard | Not classified |
| Hazardous to aquatic environment - Acute | Acute Cat. 3; H402 |
| Hazardous to aquatic environment - Chronic | Chronic Cat. 3; H412 |

[16] Respirable crystalline silica (RCS) has an industry self-classification under the GHS which classifies for the STOT-RE hazard but not the carcinogenicity hazard. In Australia, RCS at concentrations ≥ 0.1% are classified for carcinogenicity category 1A in accordance with Safe Work Australia's Hazardous Chemical Information System (HCIS) criteria. Based on its calculated RCS content of 0.5 per cent (refer to Table 4A), the Pyrrhotite Flotation Concentrate will therefore be classified as hazardous for carcinogenicity category 1A with the accompanying hazard statement H350i -*May cause cancer by inhalation* and this information should be included on the Australian product SDS.

# REPORT

## Northern Star Resources

Testing of KCGM Iron Ore Sulphide for Port Authority Handling Trials

**Date Issued**: 08/07/2025

**Version:** Final Report

Davoren Environmental Pty Ltd

ABN 93 610 442 076

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*Table i Document Control for Report 25NST-001*

| Report Version | Report Type | Date Issued | Prepared By |
|---|---|---|---|
| R0 | Draft Report | 29.05.2025 | [redacted] |
| R1 | Final Report | 08.07.2025 | |

[redacted]

Principal Consultant & Director
Davoren Environmental Pty Ltd.

# EXECUTIVE SUMMARY

A representative sample of the KCGM Iron Sulphide Concentrate was tested in May 2025 to assess its hazardous characteristics and determine the appropriate handling requirements for the material at the Port of Esperance. The assessment was conducted in line with guidance published by the Government of Western Australia. The test results were used to complete the self-assessment decision-making flowchart provided in Appendix C of the guidance. By following the relevant pathways in the flowchart based on the test outcomes, the most suitable handling method for the KCGM Iron Sulphide Concentrate (i.e., the trial material) was identified.

As illustrated in Figure 1, the self-assessment process indicated that *Minimum Handling Method 2 or 3* could be appropriate. The final decision on which method applies depends on the proximity of sensitive receptors, measured from the emission source rather than the premises boundary. Specifically, the applicable handling method is determined by the answer to the following question:

***Are there residential receptors, including short-stay accommodation, within 50 metres of the prescribed activities?***

If NO – Minimum Handling Method 2

If YES – Minimum Handling Method 3

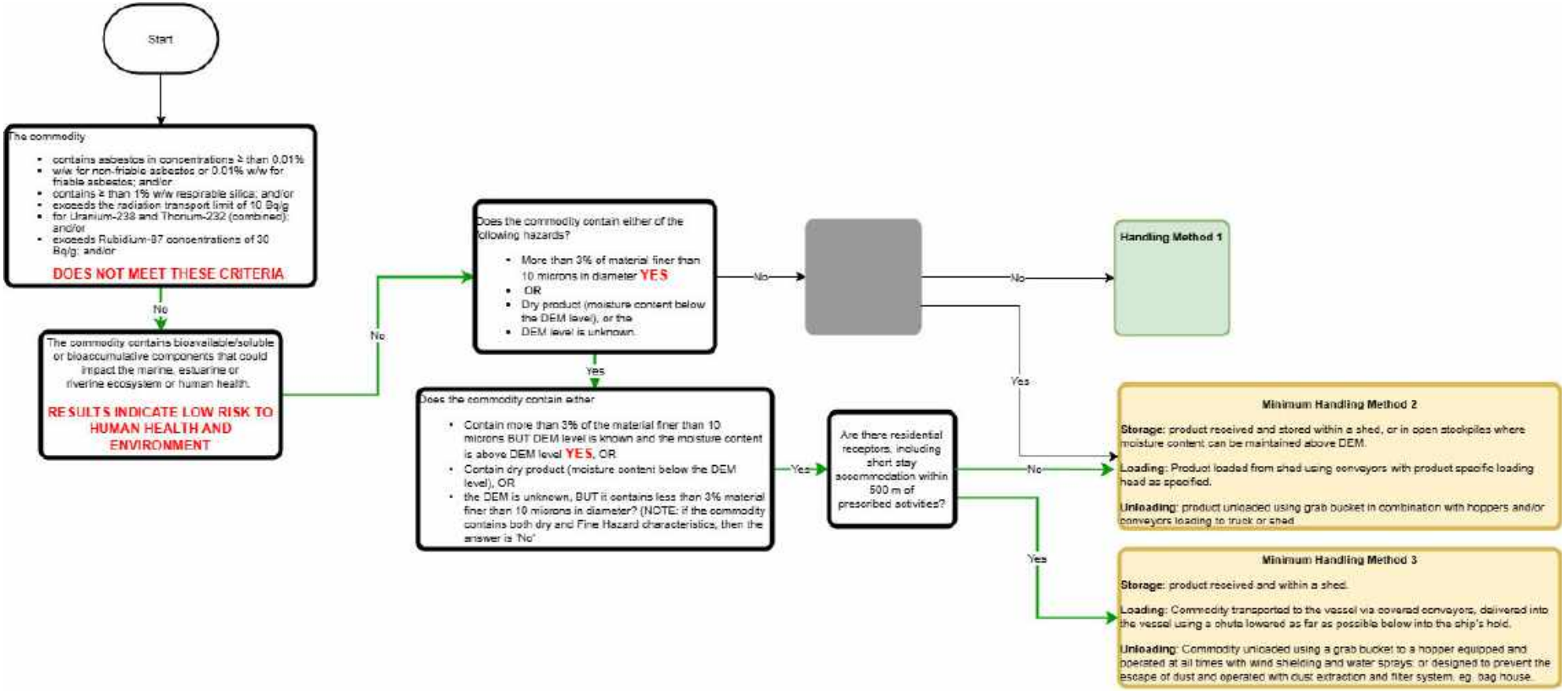


*Figure 1 Self-assessment decision-making flowchart for trialling KCGM Iron Sulphide Concentrate based on evaluated risks to human health and the environment in accordance with appropriate guidance[1]. The green arrows illustrate the logical flow path based on testing conducted as part of this assessment.*

[1] WA Department of Water and Environmental Regulation - Guideline: Port Authority Bulk Handling Trials - Category 58 and 58A

# GLOSSARY

| | |
|---|---|
| ADG | Australian Dangerous Goods Code |
| ANSTO | Australian Nuclear Science and Technology Organisation |
| ASLP | Australian Standard Leaching Procedure |
| CEN | European Committee for Standardization |
| CV-AAS | Cold Vapour Atomic Absorption Spectroscopy |
| DGVs | Default Guideline Values |
| DWER | Department of Water and Environmental Regulation |
| EAD | Equivalent Aerodynamic Diameter |
| GHS | Globally Harmonized System of Classification and Labelling of Chemicals |
| HRL | HRL Technology Group Pty Ltd |
| ICP-OES | Inductively Coupled Plasma Optical Emission Spectrometry |
| IMDG | International Maritime Dangerous Goods |
| IMSBC | International Maritime Solid Bulk Cargoes Code |
| LoQ | Limit of Quantification |
| NORM | Naturally Occurring Radioactive Material |
| PM4 | Particulate Matter ≤ 4 µm in Diameter |
| PM10 | Particulate Matter ≤ 10 µm in Diameter |
| PM100 | Particulate Matter ≤ 100 µm in Diameter |
| PSD | Particle Size Distribution |
| RCS | Respirable Crystalline Silica |
| SDS | Safety Data Sheet |
| SEM | Scanning Electron Microscopy |
| SWFF | Size-Weighted Fine Fraction |
| TEM | Transmission Electron Microscopy |
| XRD | X-ray Diffraction |

# TABLE OF CONTENTS

# 1 INTRODUCTION

Northern Star Resources engaged Davoren Environmental to conduct testing of their KCGM Iron Sulphide Concentrate. The purpose of this test work was to provide the Esperance Ports Authority with current information on the product specifications to determine the appropriate level of handling of this material in accordance with applicable guidance (WA DWER, 2018).

## 1.1 Project Scope of Work

Test work was undertaken to confirm the following to inform the self-assessment decision process:

1. The presence of asbestos
2. The presence and concentration of respirable crystalline silica
3. Naturally occurring radioactivity levels
4. Chemical make-up, mineralogy and particle size distribution (PSD) and product leachability
5. Dust Extinction Moisture

# 2 TESTING

The prescribed tests, the test laboratories subcontracted to conduct these tests, and individual report references are confirmed in Table 1. The laboratory test reports on which the classification of the concentrate was based are referenced in the report and provided separately. The KCGM Iron Ore Sulphide has been previously tested for transport classification under the Dangerous Goods Codes and was determined to be non-dangerous goods. These results are summarised in Appendix 1. Human health and environmental hazards were assessed using the chemical characterisation and mineralogical information for the KCGM Iron Ore Sulphide reported in this assessment. This assessment was conducted in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) and utilised the metals classification tool MeClas. The resulting hazard assessment is summarised in Appendix 2.

*Table 1 Hazard Criteria assessed, test laboratories, and report references*

| Criteria Assessed Required | Test Laboratory/Provider | Reference |
|---|---|---|
| Asbestos | COHLABS[2] | Attachment 1_CoA_T25-0134_Northern Star Resources Mine Site |
| Respirable crystalline silica | Microanalysis Australia Pty Ltd[3] | Attachment 2_25_0845_001 '1 KCGM Iron Sulphide Concentrate' PM4 crystalline silica report following EN17289 Report [FINAL] |
| Radiation | ANSTO | Attachment 3_Certificate of Analysis_Davoren_sbn_26_05_25 |
| Waste or Waste Derived product | NA – Not a waste | Attachment 4_KCGM_IRON_SULPHIDE_CONCENTRATE-Final_GHS_SDS |
| Bioavailable/soluble or bioaccumulative components, product leachability, particle size distribution | HRL Technology Group Pty Ltd[4] | Attachment 5_HRL_250563-01 report |
| Mineralogy (including crystalline silica) | McKnight Mineralogy | Attachment 6_Davoren 250563 KCGM May 2025 |
| Dust Extinction Moisture | TUNRA Bulk Solids | Attachment 7_TBS Report 12160 - Davoren Environmental - DEM Iron Sulphide |

[2] NATA Accreditation No. 19499, Site No. 22444
[3] NATA Accreditation No. 20283, Site No. 24180
[4] NATA Accreditation No. 561, Site No. 14658

# 3 RESULTS

## 3.1 Asbestos Analysis

The KCGM Iron Ore Sulphide Concentrate was tested for the presence of asbestos, mineral fibres (including synthetic fibres), and organic fibres using Transmission Electron Microscopy (TEM), based on the principles of the standard ISO 22262-1, as conducted by COHLABS. The analysis results confirmed that no asbestos was detected in the sample. (COHLABS, 2025)

## 3.2 Respirable Silica Quartz Analysis

Respirable (PM4) silica concentration analysis by X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM) using the modified SWFF (formerly called SWeRF) method was conducted by Microanalysis Australia (Microanalysis Australia, 2025).

The SWFF method has been developed in the industrial minerals industry to determine the "size weighted relevant fine fraction" within the bulk material (Pensis, Luetzenkirchen, & Friede, 2013). The principle behind the SWFF method is to combine the size of a particle with its probability of entering the lungs' unciliated airways, as described in the EN 481 standard (CEN, 1993). The SWFF is a fraction of a material in which the contribution of each particle is weighted as a function of its size. SWFF is thus a method for predicting how particles in a bulk material would move when it becomes airborne and is inhaled. There are two ways to determine the SWFF of a material: calculation (refer to section 3.4.2) or sedimentation. Microanalysis employed the sedimentation method whereby the respirable fraction was abstracted by settling and decantation, and SEM verified the abstracted particle size, composition, and morphology for equivalent aerodynamic diameter (EAD). Once SEM confirmed the EAD size, the abstracted fraction was analysed qualitatively and quantitatively by XRD to assess the crystalline silica concentration.

The size fraction (by aerodynamic diameter) volume per cent is confirmed below in Table 2

*Table 2 Size fraction (wt%) of KCGM Iron Sulphide Concentrate (by aerodynamic diameter)*

| Non-Inhalable | Inhalable, PM100 | Thoracic, PM10 | Respirable, PM4 |
|---|---|---|---|
| 34.52 | 65.48 | 9.35 | 3.5 |

Therefore, the respirable fraction was reported at 3.5 wt%. Based on the XRD quantification of crystalline silica, the percentage of crystalline silica in the bulk sample was calculated to be **0.317 wt%**, as shown in Table 3.

*Table 3 Respirable (PM4, wt%) crystalline silica in bulk sample*

| α-Quartz | Cristobalite | Tridymite |
|---|---|---|
| **0.317** | <0.001 | <0.001 |

## 3.3 Radioactivity Analysis

ANSTO confirmed the naturally occurring radioactivity levels of the KCGM Iron Sulphide Concentrate (ANSTO, 2025). The total activity levels of all of the naturally occurring radionuclides measured were very low and reported at **0.114 Bq/g,** and were therefore below the transport limit of 10 Bq/g (ARPANSA, 2019).

## 3.4 Chemical Characterisation, Particle Size Distribution and Leachability

Confirmation of chemical make-up (elemental analysis), particle size distribution and product leachability were conducted by HRL Technology Pty Ltd (HRL, 2025).

These analyses were conducted to confirm the human health and environmental risks associated with the material.

### 3.4.1 Elemental Analysis

The results are reported in Table 4. Further details on methods are provided in the HRL report (HRL, 2025).

*Table 4 Concentration of elements (mg/kg, dry basis) in the KCGM Iron Sulphide Concentrate*

| Element | LoQ[5] | Concentration |
|---|---|---|
| Ag | 0.10 | 17.00 |
| Al | 10.00 | 15890.00 |
| As | 4.00 | 1186.00 |
| Au | 20.00 | 40.00 |
| B | 0.08 | 13.00 |
| Ba | 0.60 | 63.00 |
| Be | 0.10 | 0.40 |
| Bi | 1.0 | <1.00 |
| Ca | 10.00 | 15195.00 |
| Cd | 0.20 | 40.00 |
| Ce | 6.00 | 17.00 |
| Co | 1.00 | 546.00 |
| Cr | 1.00 | 170.00 |
| Cu | 5.00 | 1733.00 |
| Fe | 2.00 | 348150.00 |
| Hg | 0.01 | 9.50 |
| K | 10.00 | 5240.00 |
| Li | 0.60 | 7.00 |
| Mg | 10.00 | 6906.00 |
| Mn | 10.00 | 573.00 |
| Mo | 0.10 | 51.00 |
| Na | 10.00 | 6425.00 |
| Ni | 0.10 | 600.00 |
| P | 10.00 | 263.00 |
| Pb | 1.00 | 145.00 |
| Pd | 30.00 | <30.00 |
| S | 10.00 | 364290.00 |
| Sb | 0.20 | 156.00 |
| Se | 0.60 | 51.00 |
| Si | 10.00 | 58900.00 |
| Sn | 0.70 | 3.00 |
| Sr | 1.00 | 44.00 |
| Ti | 10.00 | 4379.00 |
| Tl | 0.80 | 2.00 |
| V | 0.20 | 112.00 |
| Zn | 0.20 | 2234.00 |
| Zr | 0.20 | 72.00 |

[5] Limit of Quantification - LoQ is the lowest analyte concentration that can be quantitatively detected with a stated accuracy and precision

### 3.4.2 Particle Size Distribution

The particle size distribution was determined using laser diffraction, and the full particle size distribution (PSD) is provided in the HRL report. Data are summarised in Table 5 and confirm that the majority (~80%)of the particles were sized < 100 µm. Particle size is an important parameter for consideration in environmental and human exposure assessments. The larger the particle size, the less likely it is that the particle will be mobile in the environment, whether through air, water, or inhalation by people. Particles 100 µm or larger are typically not drawn into the body by inhalation due to their size. Relative to total airborne particles, the particle size having 50 per cent penetration for the thoracic (i.e. inhaled particles penetrating beyond the larynx) and respirable (i.e. inhaled particles penetrating to the unciliated airways) fractions in terms of aerodynamic diameter are ≤ 10 µm and ≤ 4.0 µm, respectively (Brown, Gordon, Price, & Asgharian, 2013).

*Table 5 Particle size distribution of the KCGM Iron Sulphide*

| Particle size µm | Percentage (% w/w) |
|---|---|
| > 100 | 18.9 |
| 100 – 45 | 26.8 |
| 45 - 25 | 20.0 |
| 25- 10 | 21.8 |
| <10 | 12.5 |

Applying the SWFF method (as discussed previously in Section 3.2), using the PSD data, the SWFF was calculated using the probability function of EN 481. To facilitate the use of SWFF, IMA - Europe has made available a SWFF calculation spreadsheet and guide (IMA-Europe, 2020). The SWFF (of the total sample) is calculated based on the PSD and the sample density. The SWFFcs (the SWFF of the crystalline silica (CS) in the sample) are calculated using the PSD of the sample, the density of the CS, and the content of CS determined in the sample. The PSD data reported in the HRL report were used. ATC Williams has previously reported both uncompacted and compacted bulk densities for this concentrate, using both the as-received water content and the dry density (ATC Williams Pty Ltd, 2024). The dry, uncompacted bulk density is expected to represent the worst-case scenario in terms of dust generation; hence, a value of 1,408 kg/m³ was applied in this assessment. The density of CS was entered as 2650 kg/m³. Using these parameters, the SWFF (size-weighted fine fraction) in the KCGM Iron Sulphide Concentrate was calculated as 3.4%, and the SWFF containing crystalline silica was calculated at **0.2%** as shown in Figure 2.

The SWFF values obtained through calculation (3.4%) and sedimentation (3.5%) were in excellent agreement, and there was good agreement between the levels of respirable crystalline silica determined to be in the bulk sample as calculated by sedimentation ( 0.317 %, Section 3.2) and by calculation as reported here at 0.2%.

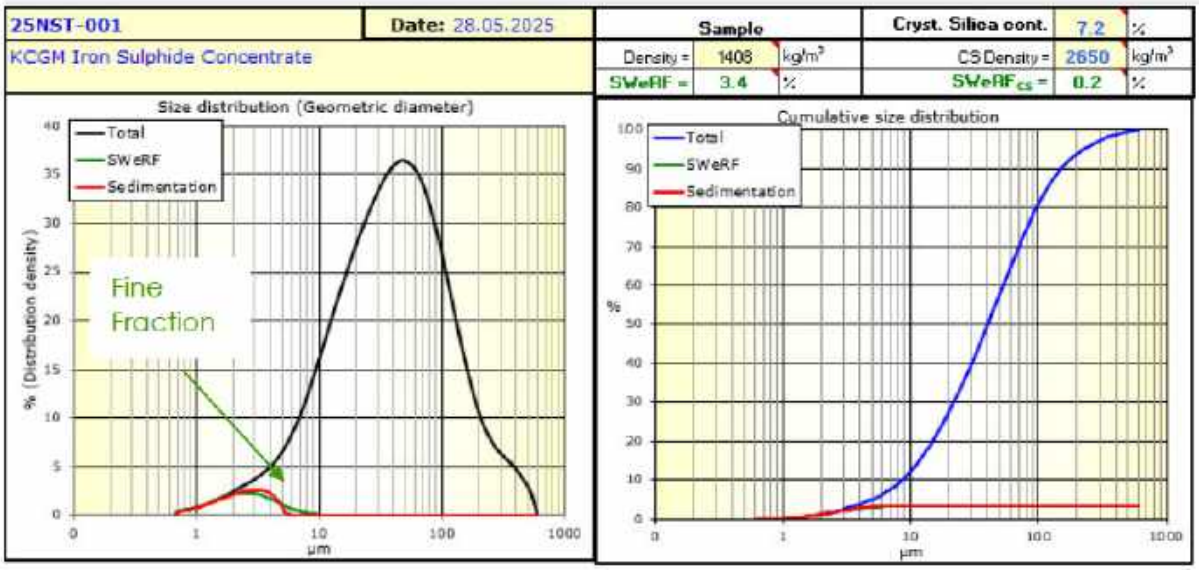


*Figure 2 SWFF calculation showing size distribution plot for the KCGM Iron Sulphide Concentrate. The green curve represents the fine fraction in the sample as calculated according to EN 481.*

### 3.4.3 Leachability

Leachate analyses are routinely conducted to characterise the mobile phase of waste or stockpiled material. The data obtained from leachate analysis can be used to classify the waste or estimate ground or surface contamination. The Western Australian Government's Department of Water and Environment Regulation (DWER) has published guidance on landfill classification and waste acceptance. The Australian Standard Leaching Procedure (ASLP), as described in AS 4439.3-1997, is the prescribed standard method for preparing these leachates. This standard provides a method for preparing leachates from liquid and solid wastes, sediments, sludges, and soils to assess the potential for non-volatile inorganic and semi-volatile organic contamination of groundwater in various land disposal scenarios.

The total concentration of metals and metalloids was determined according to EPA Method 200.2 revision 2.8 using ICP-OES and Cold Vapour Atomic Absorption Spectroscopy (CV-AAS). Hexavalent chromium (Cr(VI)) was determined using EPA Method 3060A and Method 7196A. HRL prepared two types of leachate: the first using deionised water as a reagent and the second using a more acidic pH acetate buffer. The acidic pH provides a conservative estimate of leaching potential, while deionised water is often employed as a leaching agent for assessing the leaching potential of waste rocks and tailings at mine sites (WA DWER, 2015). Following the preparation of these leachates, the concentration of metals in each leachate was determined using

ICP-OES and CV-AAS. Leachable Cr(VI) was not determined as there was no Cr (VI) detected in the material.

Results demonstrate that a slight leaching of molybdenum (Mo) was detected at its respective limit of quantification (LoQ) of 0.01 mg/L (equivalent to 10 µg/L), in the reagent water leachate. No other metals were detected in the reagent water leachate. There was some leaching of nickel (Ni) (0.11 mg/L or 110 µg/L) and lead (Pb) (0.03 mg/L or 30 µg/L) in the pH 5 leachate. These results are presented in Table 6.

*Table 6 Concentration (mg/kg, dry basis) of total and leachable inorganic species from reagent (deionised) water and acetate buffer (pH 5)*

| Element[6] | Total Conc mg/kg | LOQ Leachate | Reagent Water mg/L | Acetate Buffer pH 5 mg/L |
|---|---|---|---|---|
| Ag | 17.00 | 0.02 | <0.02 | <0.02 |
| As | 1133.00 | 0.02 | <0.02 | <0.02 |
| Be | 0.04 | 0.01 | <0.01 | <0.01 |
| Cd | 40.00 | 0.01 | <0.01 | <0.01 |
| Cr (VI) | <0.01 | 0.01 | <0.01 | <0.01 |
| Hg | 9.20 | 0.001 | <0.001 | <0.001 |
| Mo | 16.00 | 0.01 | **0.01** | <0.01 |
| Ni | 578.00 | 0.01 | <0.01 | **0.11** |
| Pb | 135.00 | 0.02 | <0.02 | **0.03** |
| Se | 27.00 | 0.02 | <0.02 | <0.02 |
| Other Metals: Al, Ba, B, Co, Cu, Mn, V, and Zn | 0.57% by weight | - | NA[7] | NA |

To assess whether these levels of leachable metals could adversely impact freshwater or marine ecosystems, the leachable metal concentrations for Mo, Ni, and Pb were compared to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality default quality guidelines (DGVs) for these toxicants.[8]

Molybdenum was the only metal detected in the reagent water leachate. This leachate is considered the most representative of likely leaching conditions relevant to a port loading scenario, such as exposure to rainfall or operational water (e.g., dust suppression misters). The measured Mo concentration was found to be below the applicable DGVs for both freshwater and marine environments, indicating a low risk of environmental harm under typical operational conditions.

[6] These are the relevant metals listed in the DER guidance (WA DWER, Landfill Waste Classification and Waste Definitions 1996 (as amended 2019), 2019).
[7] NA – Not Applicable
[8] www.waterquality.gov.au/guidelines/anz-fresh-marine

Nickel and lead were detected in the pH 5 leachate, which is intended to simulate a conservative, acidic scenario reflecting potential worst-case leaching conditions. While concentrations of both metals exceeded their respective freshwater and marine DGVs under these conditions, these results are not necessarily indicative of expected environmental concentrations; rather, they provide insight into potential metal mobility under acidified conditions.

*Table 7 Comparison of leachable metal concentrations (µg/l) from reagent water (RW) and acetate buffer pH 5 (pH 5) to their ANZG default quality guidelines (DGVs)*

| Metal | Leachate Type | Leachate Conc. (µg/L) | ANZG DGV Freshwater (µg/L) | ANZG DGV Marine Water (µg/L) | Exceeds Freshwater DGV? | Exceeds Marine DGV? |
|---|---|---|---|---|---|---|
| **Mo** | RW | 10 | 34 | 23 | No | No |
| | pH 5 | <LoQ | 34 | 23 | NA | NA |
| **Ni** | RW | <LoQ | 11 | 70 | NA | NA |
| | pH 5 | 110 | 11 | 70 | Yes | Yes |
| **Pb** | RW | <LoQ | 3.4 | 4.4 | NA | NA |
| | pH 5 | 30 | 3.4 | 4.4 | Yes | Yes |

## 3.5 Mineralogy Composition

McKnight Mineralogy conducted semi-quantitative XRD (McKnight Mineralogy, 2025). This analysis confirmed the mineralogy of the sample, and the results (including the amorphous content) are provided in Table 8

*Table 8 Mineralogy of the KCGM Iron Sulphide Concentrate*

| Mineral or Mineral Group | Concentration ( %) |
|---|---|
| Pyrite ($FeS_2$) | 67.5 |
| Quartz ($SiO_2$) | 7.2 |
| Muscovite-2M ($KAl_2(AlSi_3O_{10})(F,OH)_2$) | 5.5 |
| Albite ($NaAlSi_3O_8$) | 4.5 |
| Ankerite ($Ca(Fe,Mg,Mn)(CO_3)_2$) | 4.0 |
| Clinochlore-Fe ($Mg_5Al(AlSi_3O_{10})(OH)$) | 4.0 |
| Siderite-Mg ($FeCO_3$) | 2.4 |
| Pyrrhotite-4M | 2.1 |
| Calcite ($CaCO_3$) | 0.8 |
| Chalcopyrite ($CuFeS_2$) | 0.6 |
| Sphalerite-Fe (ZnS) | 0.5 |
| Talc ($Mg_3Si_4O_{10}(OH)_2$) | 0.5 |
| Microcline ($KAlSi_3O_8$) | 0.4 |
| Amorphous | 0.0 |

## 3.6 Dust Extinction Moisture Testing

The Dust Extinction Moisture (DEM) is defined as the moisture level at which a material is deemed to emit no dust, as determined using Australian Standard AS 4156.6 (Standards Australia, 2000 (R2013)). This standard was written specifically for coal but has been utilised for other bulk materials by modifying the quantity of sample placed in the test rig.

In summary, a representative sub-sample of the concentrate, which equated to approximately 1 litre of the test sample, was weighed and transferred to a sealed drum, which was then rotated at a speed of 29 rpm for 10 minutes while an airflow rate of 175 L/min was drawn through a hole in the drum lid, through a hollow drive shaft and into a paper filter bag which collected the dust generated in the drum. Testing was performed in a controlled environment at 20 ± 2°C and a relative humidity of 63 ± 2% RH.

The test work was conducted on a number of samples over a range of moistures, and the dust numbers obtained were plotted on a log-linear graph.

The test determined a dust number for each of the measured moisture contents as follows:

$$\frac{mass\ of\ dust\ collected}{original\ mass\ of\ sample}\ x\ 100{,}000$$

The DEM was determined by the intersection of a regression line through relevant dust-moisture data points at a dust number of 10. The actual DEM value is only totally representative if conditions (airspeed, material stream characteristics, etc.) are identical to those inside the test rig. However, the observed relationship between dust and moisture may be consulted to determine the sensitivity of the material to dust control by the addition of moisture. The DEM of the KCGM Iron Sulphide Concentrate was reported at **1.53 %**. Full test details are available in the report (Tunra Bulk Solids, 2025).

# 4 SUMMARY OF TEST RESULTS

A summary of the test results is provided in Table 9 below.

*Table 9 Summary of test results*

| Environment Items Required by PPA | Outcome |
|---|---|
| Asbestos | • No asbestos detected |
| Respirable crystalline silica | • 0.317 wt % |
| Radiation | • Not a radioactive material[9] |
| Waste or Waste Derived product | • Not Applicable |
| Bioavailable/soluble or bioaccumulative components, product leachability, particle size distribution | • Leaching studies demonstrated<br>o Mo was the only metal detected in the RW leachate (representing typical port conditions); its concentration was below freshwater and marine DGVs, indicating low environmental risk.<br>o Ni and Pb were detected in the pH 5 leachate (worst-case acidic scenario); both exceeded DGVs, suggesting potential metal mobility under acidified conditions, but not necessarily reflective of actual environmental concentrations.<br>• Size weight fine fraction confirmed by sedimentation of 3.5% (Section 3.2) and by calculation of 3.4% (Section 3.4.2) |
| Mineralogy (including crystalline silica) | Confirms iron sulphide concentrate (pyrite) |
| Dust Extinction Moisture | 1.53% |

As illustrated in Figure 3, these test outcomes suggest that Minimum Handling Method 2 or 3 may be suitable. The final decision on which method applies depends on the minimum separation distance to sensitive receptors measured from the emission source.

[9] The levels of the naturally occurring radionuclides in the concentrate do not exceed 10 Bq g$^{-1}$ limit. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) have set an exemption limit of 10 Bq g$^{-1}$ that applies for the transport of bulk materials or individual items, as is designed so that large quantities of Naturally Occurring Radioactive Material (NORM) that present a very low radiation hazard do not have to be transported as a radioactive material (ARPANSA, 2015).

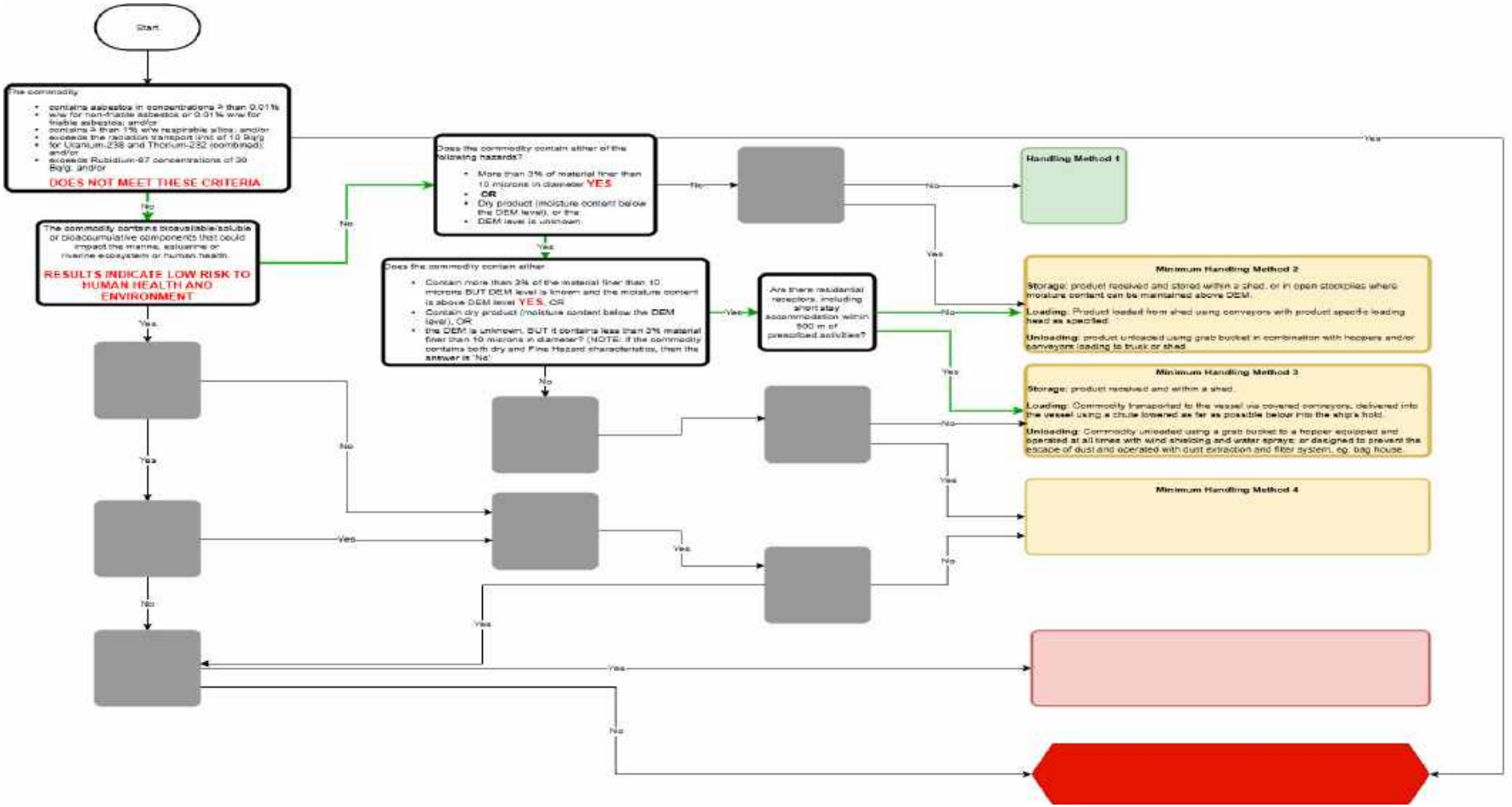


*Figure 3 Self-assessment decision-making flowchart for trialling KCGM Iron Sulphide Concentrate based on evaluated risks to human health and the marine, riverine or estuarine environment. The green arrow illustrates the logical flow path, and the empty boxes were determined not to be relevant based on test results from this study.*

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# APPENDIX 1. TRANSPORT CLASSIFICATION

The KCGM Iron Sulphide Concentrate has been previously tested and has been classified as non-dangerous goods under the Australian Dangerous Goods (ADG) and International Maritime Dangerous Goods (IMDG) Codes. Under the International Maritime Solid Bulk Cargoes (IMSBC) Code, it is categorised as a Group A cargo (liable to liquefy). Under MARPOL Annex V, it is classified as not Harmful to the environment (not HME). The results are summarised below in Table 1a.

*Table 1a Classification of KCGM Iron Sulphide Concentrate according to Dangerous Goods (ADG, IMDG), IMSBC (MHB), and MARPOL Annex V (HME) criteria*

| Hazard | Classification Criteria | Classification outcome |
|---|---|---|
| **Australian (ADG) and International Maritime Dangerous Goods (IMDG) Codes** | | |
| **Classes 1 – 3 and 5** | Based on relevant product information and physicochemical properties | No classification required |
| **Class 4** | Division 4.1 Flammable solids | No classification required |
| | Division 4.2 Substances liable to spontaneous combustion | No classification required |
| | Division 4.3 Water reactive substances | No classification required |
| **Class 6.1** | Toxic Substance | No classification required |
| **Class 7** | Radioactive Substance | No classification required |
| **Class 8** | Corrosive Substances | No classification required |
| **Class 9** | Environmentally Hazardous Substance (EHS) | No classification required |
| **IMSBC Code, Materials Hazardous only in Bulk (MHB)** | | |
| **MHB (CB)** | Combustible Solids | No classification required |
| **MHB (SH)** | Self-heating Solids | No classification required |
| **MHB (WF)** | Solids that evolve into flammable gas when wet | No classification required |
| **MHB (WT)** | Solids that evolve into toxic gas when wet | No classification required |
| **Toxic Solids MHB (TX)** | Acute Toxicity-Inhalation 4 | No classification required |
| | STOT-SE/STOT-RE–Inhalation 1 | No classification required |
| | Acute Toxicity-Dermal 4 | No classification required |
| | STOT-SE/STOT-RE–Dermal 1 | No classification required |
| | Carcinogenicity, Mutagenicity, Reprotoxicity 1A and 1B | No classification required |
| **Corrosive Solids MHB (CR)** | Respiratory Sensitiser 1 | No classification required |
| | Skin Corrosion/Irritation 2 | No classification required |
| | Eye damage/Irritation 1 or 2A | No classification required |
| | Corrosion to metals | No classification required |
| **MARPOL Annex V (HME)** | | |
| **Environmental and Human Health Criteria** | Acute Aquatic Toxicity Category 1 | No classification required |
| | Chronic Aquatic Toxicity Category 1 or 2 | No classification required |
| | Carcinogenicity 1A or 1B | No classification required |
| | Mutagenicity Category 1A or 1B | No classification required |
| | Reproductive Toxicity Category 1A or 1B | No classification required |

| | | |
|---|---|---|
| | STOT-RE Category 1 | No classification required |
| | Synthetic polymer, rubber or plastic | No classification required |

# APPENDIX 2. GHS CLASSIFICATION RESULTS

The classification was conducted using the metals classification tool MECLAS version 5.15 http://www.meclas.eu. Results are presented in Table 2a.

*Table 2a GHS classification for the KCGM Iron Sulphide Concentrate based on chemical analysis and mineralogy data*

| GHS Hazard Endpoint | GHS Classification Category | Driver |
|---|---|---|
| Acute toxicity-oral | Not classified | - |
| Acute toxicity-dermal | Not classified | - |
| Acute toxicity-inhalation | Not classified | - |
| Skin corrosion/irritation | Not classified | - |
| Serious eye damage/eye irritation | Not classified | - |
| Respiratory or skin sensitisation | Not classified | - |
| Germ cell mutagenicity | Not classified | - |
| Carcinogenicity | Not classified[10] | - |
| Reproductive toxicity | Not classified | - |
| Specific target organ toxicity - single exposure | Not classified | - |
| Specific target organ toxicity - repeated exposure | Cat. 2; H373 | - |
| Aspiration hazard | Not classified | - |
| Hazardous to the aquatic environment - ACUTE | Acute Cat. 2; H401 | Cu |
| Hazardous to the aquatic environment - CHRONIC | Chronic Cat. 3; H412 | Cu |

[10] Respirable crystalline silica (RCS) has an industry self-classification under the GHS, classifying it for the STOT-RE hazard but not the carcinogenicity hazard. In Australia, RCS at concentrations ≥ 0.1% are classified for carcinogenicity category 1A in accordance with Safe Work Australia's Hazardous Chemical Information System (HCIS) criteria. Based on testing conducted by Microanalysis, the crystalline silica content in the bulk sample was confirmed as 0.317%. The KCGM Iron Concentrate shall therefore be classified as hazardous for carcinogenicity category 1A with the accompanying hazard statement H350i -May cause cancer by inhalation, and this information should be included on the product SDS.

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Mt Lawley, WA 6050
+61 8 9225 5810

**Laboratory Report**

| | | | |
|---|---|---|---|
| **Client:** | Davoren Environmental | **Date received:** | 12/05/2025 |
| **Client address:** | 14 Rosserdale Crescent, Mount Eliza, VIC, 3930 | **Date analysed:** | 14/05/2025 |
| **Job ID:** | 25_0845 | **Date reported:** | 14/05/2025 |
| **Lab ID:** | 25_0845_001 | **Revision no.:** | 0 |
| **Client ID:** | 1 KCGM Iron Sulphide Concentrate | | |
| **Comments:** | None | | |

**Analysis:** PM4 crystalline silica concentration analysis by X-ray diffraction (XRD) and scanning electron microscopy (SEM) using the modified SWeRF (EN17289) method[1]

**Sample preparation**

The sample was supplied to Microanalysis Australia as a bulk material. The sample was tested as received, and all testing was conducted in Water.

A representative sub-sample of was taken from the as-received sample, thoroughly homogenised and sized by laser diffraction, reporting size >20 nm.

The PM4 fraction was abstracted by settling and decantation using Stokes' Law, and the abstracted particle size, composition, and morphology was verified by scanning electron microscope (SEM) for the equivalent aerodynamic diameter (EAD) of 4 µm.

Once the equivalent aerodynamic size was verified by SEM, the abstracted fraction was analysed qualitatively and quantitatively by XRD to assess the crystalline silica concentration.

**Results**

The sample was analysed as received as no pre-screening was required to obtain the correct initial topsize.

The laser diffraction size distribution analyses were conducted using a Malvern Mastersizer MS2000 calibrated using QAS3002 certified reference material and certified within specification. The analyses were conducted following ISO13320-1:2020.

For the sedimentation, the time for a specific fall height for PM4 particles was calculated using Stokes Law. The samples were then homogenised and allowed to settle for the calculated time before the supernatant was decanted off, down to the limit of the fall height. The density and viscosity of water at 21 °C, and an assumed particle density of 2.65 g/cc were used.

The electron microscope used was a Carl Zeiss EVO50 equipped with an Oxford Instruments AZtec software and X-Max energy dispersive spectrometer (EDS). All images were acquired using backscatter electrons, unless otherwise specified to highlight particle composition. The contrast in backscatter electron images is proportional to average elemental composition i.e. the brighter the particle the higher the atomic number. Some images with contrasting brightness particles were examined by EDS for elemental composition.

The extracted fraction was deposited on a filter membrane for XRD analysis. Quantification was by the RIR method. Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non-crystalline) material will add to the background but is estimated by the software. Amorphous phases cannot be speciated by XRD. The search match software used was EVA (Bruker). The ICDD card set was ICDD PDF4+ 2021. The X-ray source was cobalt radiation. ICCD match probabilities are reported as an indication of how well the diffraction peaks of this sample compare with currently published literature on the quoted mineral. No Rietveld refinement was conducted on the acquired pattern unless otherwise stated. The amorphous fraction was estimated from the background shape.

The PM4 fraction (as defined in ISO 7708) crystalline silica concentration of the bulk was calculated by multiplying the volume percent of the PM4-only fraction by the α-quartz, cristobalite, and tridymite concentrations of the PM4-only fraction.

**Summary**

The size distribution of the sample by wet sieving and laser diffraction is shown below:

| Client ID | Size fraction (by aerodynamic diameter) volume percent | | | | |
|---|---|---|---|---|---|
| | > PM100 | PM100 | PM10 | PM4 | PM2.5 |
| 1 KCGM Iron Sulphide Concentrate | 34.52 | 65.48 | 9.35 | 3.50 | 1.93 |

Assuming all mineral phases occur at the same relative concentrations across all size intervals, a volume percent distribution equates to a mass distribution. The PM4 fraction, is therefore 3.50 wt%.

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The normalised, interpreted semi-quantitative mineralogy by XRD of the abstracted PM4 fraction is shown below:

| Crystalline mineral phase | PM4 concentration (wt%) | ICDD match probability |
|---|---|---|
| Pyrite (FeS2) | 14 | High |
| Quartz (SiO2) | 11 | High |
| Sodium Plagioclase (NaAlSi3O8) | 8 | High |
| Dolomite (CaMg(CO3)2) | 7 | Medium |
| Mica ((K,Ca,Na,Li)(Al,Mg,Fe)2(Si,Al)4O10(OH)2) | 18 | Medium |
| Chlorite ((Mg,Al)6(Si,Al)4O10(OH)8) | 27 | High |
| Calcite (Ca(CO3)) | 2 | Low |
| Laumontite (CaAl2Si4O12 · 4H2O) | 5 | Low |
| Talc-1A (Mg3Si4O10(OH)2) | 8 | Low |

The XRD interpretation estimated the PM4 fraction to be approximately 16 wt % amorphous. The above percentages represent only the crystalline fraction.

The PM4 fraction crystalline silica concentrations with respect to the bulk sample are shown below:

| Client ID | PM4 wt% of the bulk material for mineral phase | | |
|---|---|---|---|
| | α-Quartz | Cristobalite | Tridymite |
| 1 KCGM Iron Sulphide Concentrate | 0.317 | <0.001 | <0.001 |

Note: Three polymorphs of crystalline silica are scheduled as Group 1 carcinogens by IARC – α-quartz, cristobalite and tridymite[2].

**Analysed by:** [redacted] Ph.D. Physics
**Reported by:** [redacted], Ph.D. Physics
**Approved by:** [redacted] B.Sc.(Multidisciplinary)

[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3979281/
[2] https://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-14.pdf

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Greenslopes, QLD 4120
PO Box 635, Coorparoo QLD 4151
Tel. +61 (0)7 3015 7555

# CERTIFICATE OF ANALYSIS

## Asbestos Identification - TEM

Certificate No: T25-0134

| | | | |
|---|---|---|---|
| **Client:** | Davoren Environmental Pty Ltd | **Date Sampled:** | Unknown |
| **Client Contact:** | [redacted] | **Date Received:** | 12/05/2025 |
| **Telephone:** | | **Date Analysis Complete:** | 21/05/2025 |
| **Email:** | | **Date Issued:** | 23/05/2025 |
| **Address:** | | **Order No.:** | 25NST-001 |
| **Site:** | Northern Star Resources Mine Site | **Sampled By:** | As Received |

**Test Method:**

Samples analysed by Transmission Electron Microscopy (TEM) at COHLABS Greenslopes laboratory based on the principles of standard ISO 22262-1 — "International Standard, Part 1: Air quality — Bulk materials: Sampling and qualitative determination of asbestos in commercial bulk materials."

| Lab ID | Sample ID | Sample Details | Sample Type | Size / Weight cm/g | Analysis Result |
|---|---|---|---|---|---|
| TEM001 | Sample 1 | KCGM Iron Sulphide | Black Ore Material | 31g | NAD |

**Identification Legend**

CHR - Chrysotile Asbestos
AMO - Amosite Asbestos
CRO - Crocidolite Asbestos
TRE - Tremolite Asbestos
ACT - Actinolite Asbestos
ANT - Anthophyllite Asbestos
NAD - No Asbestos Detected

**Approved Analyst**

Name: [redacted]

**Approved Signatory**

Name: [redacted]

**Notes:**

The results contained within this report relate only to the sample(s) submitted for testing.

COHLABS accepts no responsibility for the initial collection, packaging or transportation of samples submitted by external persons.

Sample material descriptions and results reported may be limited by the size and condition of the sample submitted for analysis. Sizes and weights stated are approximate only.

All analytical data such as analytical sensitivity, number of grid openings analysed, average grid opening size, micrograph and EDS spectra identification is available on request.

Samples are routinely disposed of approximately 1 month from receipt. Requests for longer term sample storage must be received in writing.



NATA Accreditation number: 19499
Accredited for compliance with ISO/IEC: 17025 - Testing

ABN: 62 166 540 094

# 1 Analysis results

## 1.1 Summary table

The purpose of the analysis was to find / observe fibres and EMPs (Elongated Mineral Particles or "Cleavage Fragments"), assess their crystallinity by electron diffraction and assess their chemical composition by EDX.

*Table 1 Summary table of fibres and elongated mineral particles detected within the samples*[1]

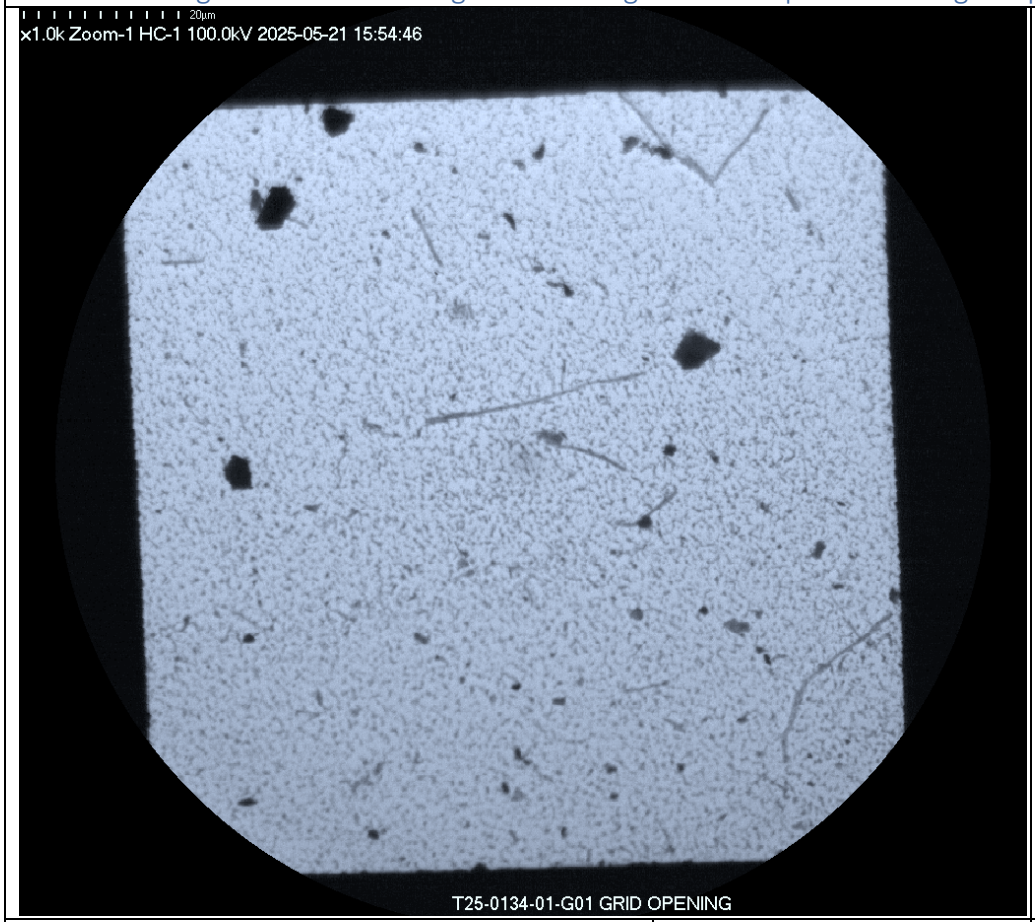
| ID | | #GO SCANNED | | STRUCTURES DETECTED / RESULTS | |
|---|---|---|---|---|---|
| CLIENT ID | LAB ID | TOTAL | TOTAL AREA (MM2) | STRUCTURES | FIBRES |
| 25NST-001 KCGM IRON SULPHIDE | T25-0134-01 | 16 | 0.128 | - AlSiKO EMPs*[2]<br>- SFe PARTICLES | - NO ASBESTOS DETECTED |

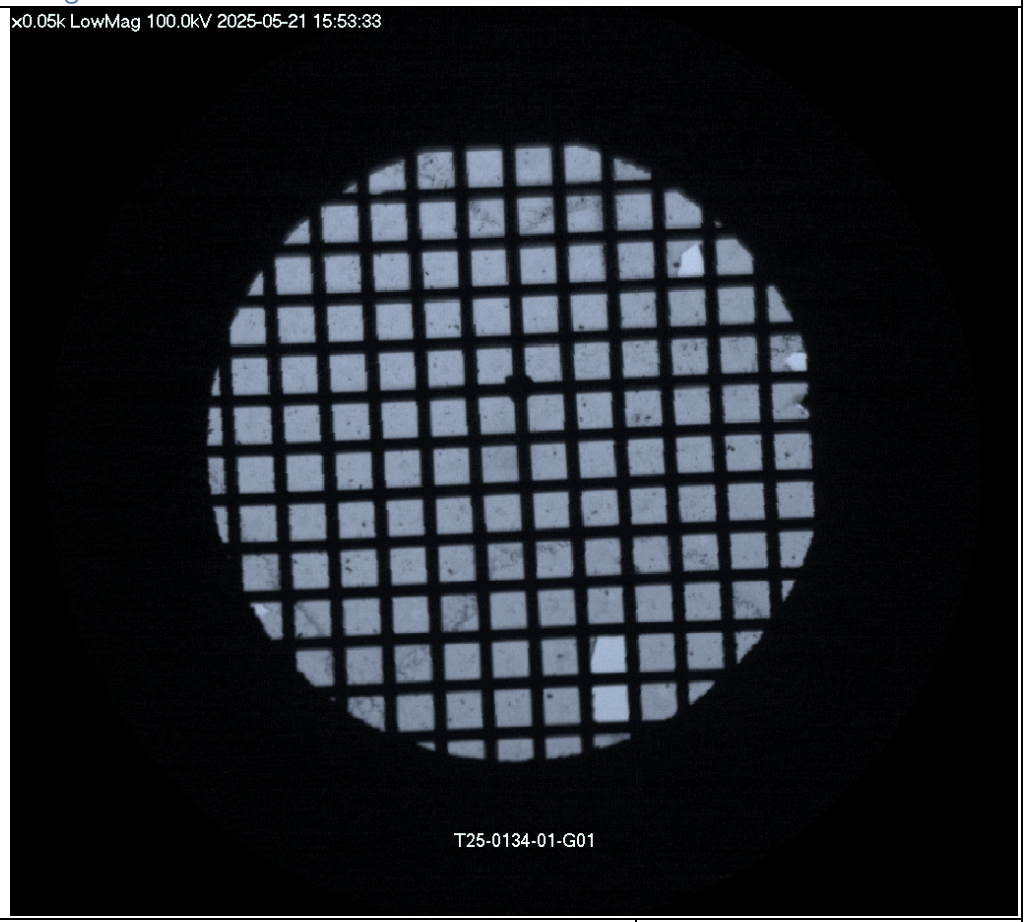
[1] Explanatory notes to the table:

- EFA: Funnel Effective Filtration Area (in $mm^2$)
- EFD: Funnel Effective Filtration Diameter (in mm)
- GOA: Grid Opening Area (in $mm^2$)

[2] * Details of fibres and elongated mineral particles identification shown in pages below. Additional TEM images and EDX spectrums can be provided upon request.

## 1.2 Low magnification TEM images of a TEM grid and a representative grid opening



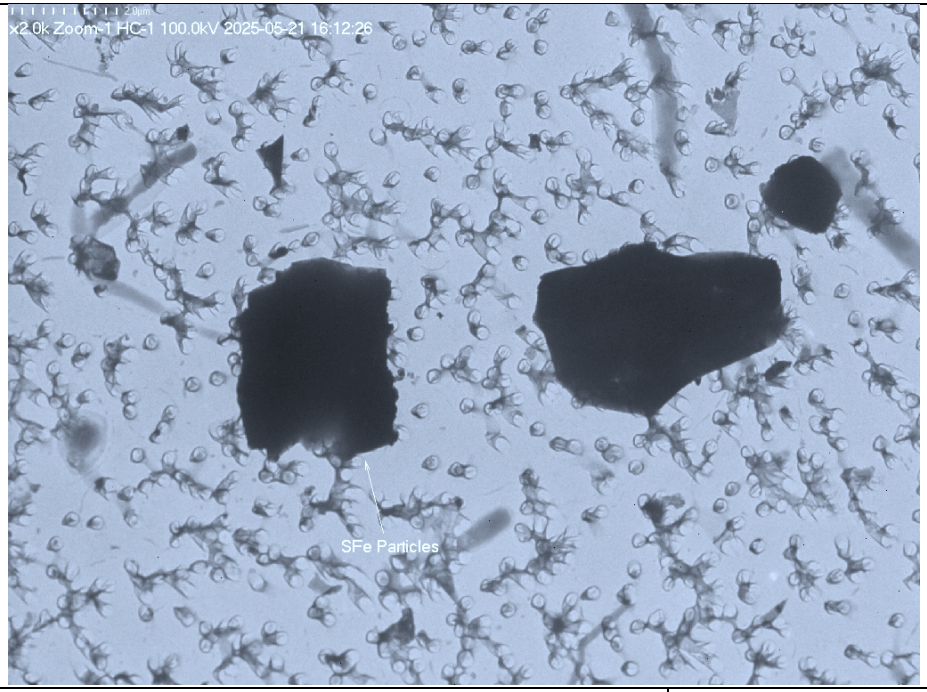

| | | | |
|---|---|---|---|
| Standard / Display Magnification:[3] | X01.00K / X02.00K | Standard / Display Magnification: | X00.05K / X00.10K |
| Reference: | T25-0134-01-G01 | Reference: | T25-0134-01-G01 |

[3] Extracted from HT7700 Software Manual: *"Standard Magnification: in an instrument model equipped with the integration CCD camera, the magnification of an image projected at the CCD (scintillator) position is taken as a magnification standard.*
*Display Magnification: Display magnification refers to a magnification factor on the display monitor."*

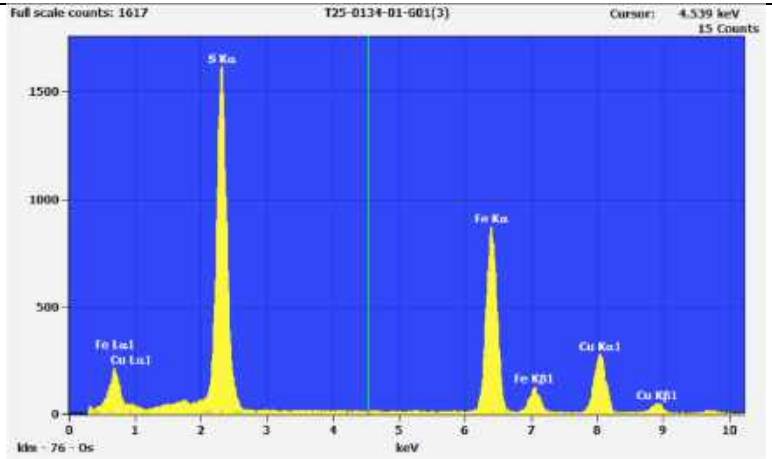
## 1.3 Examples of structures identified

### 1.3.1 Sample T25-0134-01 [Client ID: 25NST-001 KCGM IRON SULPHIDE]: Example of Sulphur-Iron based particles identified.

#### *1.3.1.1 TEM OBSERVATION*




#### *1.3.1.2 EDX SPECTRUM*




Quantitative Results for: T25-0134-01-G01(3)

| Element Line | Net Counts | Net Counts Error | K-Factor | Weight % | Weight % Error | Atom % | Atom % Error | Formula | Compnd % |
|---|---|---|---|---|---|---|---|---|---|
| O K | 0 | 0 | --- | 47.28S | --- | 69.50 | ± 0.00 | (null) | --- |
| S K* | 28810 | ± 185 | 0.938 | 26.58 | ± 0.17 | 19.50 | ± 0.13 | SO3 | 66.37 |
| Fe K | 18987 | ± 147 | 1.400 | 26.14 | --- | 11.01 | ± 0.09 | FeO | 33.63 |
| Total | | | | 100.00 | | 100.00 | | | 100.00 |

| | | | |
|---|---|---|---|
| Standard / Display Magnification:[4] | X02.00K / X15.00K | Tilt angle | 20 deg |
| Emission current: | 10 uA | Acquisition time | 30-60 sec |
| Acceleration voltage: | 100 kV | | |

FIBRE DEFINITION AS PER ISO 22262-1:

*"elongated particle which has parallel or stepped sides, For the purposes of this part of ISO 22262-1, a fibre is defined to have an aspect ratio equal to or greater than 3:1."*

OBSERVATION: This structure DOES NOT meet the criteria of a fibre as per ISO 22262-1.

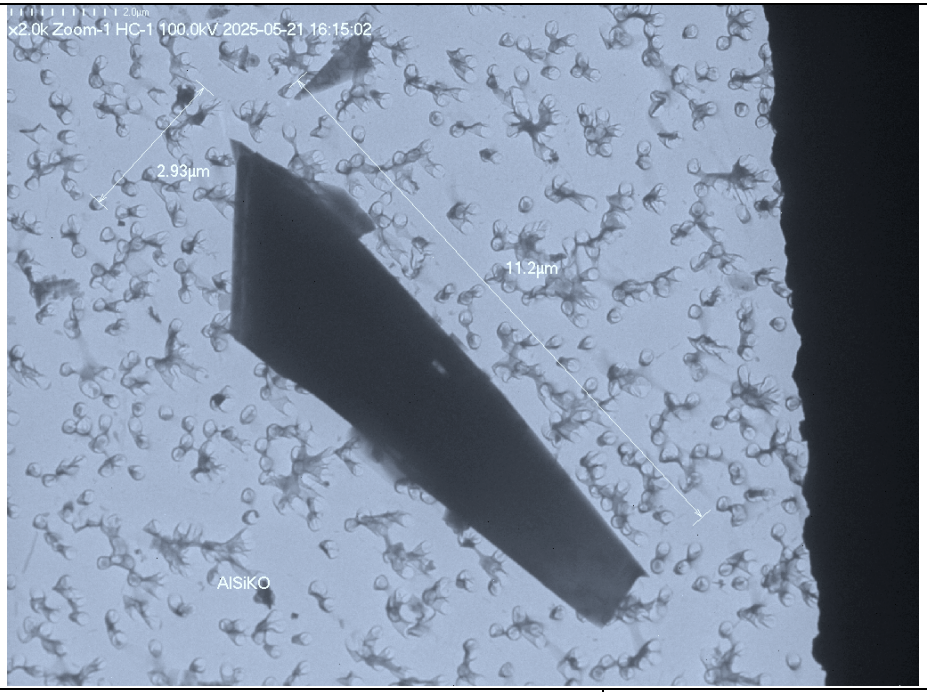
*The EDX spectrum identifies the presence of SULPHUR and IRON, and IS NOT qualitatively similar to the EDX spectrum of asbestos.*

RESULT: SULPHUR-IRON BASED PARTICLES IDENTIFIED.

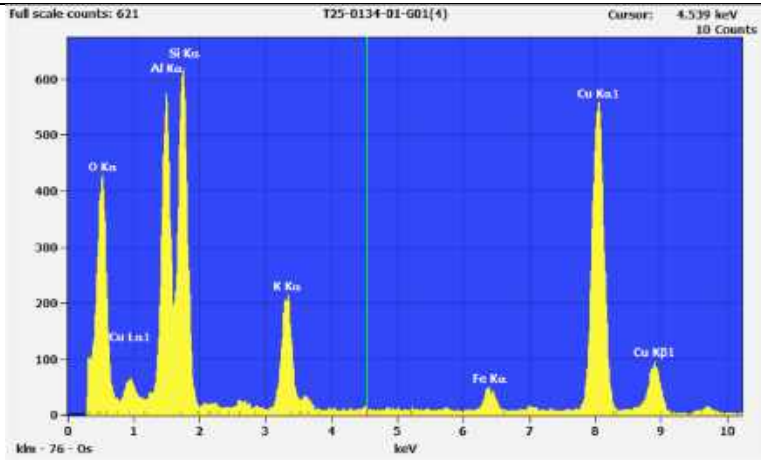
[4] Extracted from HT7700 Software Manual: *"Standard Magnification: in an instrument model equipped with the integration CCD camera, the magnification of an image projected at the CCD (scintillator) position is taken as a magnification standard.*
*Display Magnification: Display magnification refers to a magnification factor on the display monitor."*

## 1.3.2 Sample T25-0134-01 [Client ID: 25NST-001]: Example of Aluminosilicate structures identified.

### *1.3.2.1 TEM OBSERVATION*




### *1.3.2.2 EDX SPECTRUM*




Quantitative Results for: T25-0134-01-G01(4)

| Element Line | Net Counts | Net Counts Error | K-Factor | Weight % | Weight % Error | Atom % | Atom % Error | Formula | Compnd % |
|---|---|---|---|---|---|---|---|---|---|
| O K | 0 | 0 | --- | 45.68S | --- | 61.11 | ± 0.00 | (null) | --- |
| Al K | 8731 | ± 101 | 0.975 | 19.23 | --- | 15.25 | ± 0.18 | Al2O3 | 36.33 |
| Si K | 10035 | ± 108 | 1.000 | 22.66 | --- | 17.27 | ± 0.19 | SiO2 | 48.49 |
| K K | 3939 | ± 69 | 1.100 | 9.79 | --- | 5.36 | ± 0.09 | K2O | 11.79 |
| Fe K | 836 | ± 36 | 1.400 | 2.64 | --- | 1.01 | ± 0.04 | FeO | 3.40 |
| Total | | | | 100.00 | | 100.00 | | | 100.00 |

| | | | |
|---|---|---|---|
| Standard / Display Magnification:[5] | X02.00K / X15.00K | Tilt angle | 20 deg |
| Emission current: | 10 uA | Acquisition time | 30-60 sec |
| Acceleration voltage: | 100 kV | | |

FIBRE DEFINITION AS PER ISO 22262-1:

*"elongated particle which has parallel or stepped sides, For the purposes of this part of ISO 22262-1, a fibre is defined to have an aspect ratio equal to or greater than 3:1."*

OBSERVATION: This structure DOES NOT meet the criteria of a fibre as per ISO 22262-1.

*The EDX spectrum identifies the presence of OXYGEN, ALUMINIUM, SILICON and POTASSIUM, and IS NOT qualitatively similar to the EDX spectrum of asbestos.*

RESULT: ALUMINOSILICATE STRUCTURE IDENTIFIED.

[5] Extracted from HT7700 Software Manual: *"Standard Magnification: in an instrument model equipped with the integration CCD camera, the magnification of an image projected at the CCD (scintillator) position is taken as a magnification standard.*
*Display Magnification: Display magnification refers to a magnification factor on the display monitor."*

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# CERTIFICATE OF ANALYSIS

| | |
|---|---|
| **Certificate Number:** | 20250527 |
| **Company / Organisation:** | Davoren Environmental |
| **AM Request Number:** | 2501082 |
| **Sample Identification:** | KCGM Iron Sulphide Concentrate (25NST-001) |
| **AM Identification:** | DAV-140525-1 |
| **Analysis Requested:** | Natural Radioactivity (U-238, Th-232 and Rb-87) |

One (1) sample of iron sulfide concentrate (25NST-001) was received on 14 May 2025. The sample was analysed, as-received, in accordance with controlled document:

*Fusion Digestion with ICPMS Finish (U, Th, Rb)*

G-5913 Analytical Methods Manual.

The radionuclide results are given in Table 1. The activity concentrations of U-238 and Th-232 were calculated from the measured U and Th concentrations from ICPMS using the respective specific activities. The activity concentration of Rb-87 was calculated from the measured Rb concentration from ICPMS using natural abundance.

**Table 1**
**Elemental and Activity Concentrations**

| Radionuclide | Element (µg/g) | Activity (Bq/g) |
|---|---|---|
| U-238 | < 10 | < 0.12 |
| Th-232 | 26 ± 13 | 0.10 ± 0.05 |
| Rb-87 | 17 ± 9 | 0.014 ± 0.007 |

[redacted] **Senior Radiochemist** **Date: 27 May 2025**

# Safety Data Sheet

**Hazardous, NON-Dangerous Goods**

## 1. MATERIAL AND SUPPLY COMPANY IDENTIFICATION

**Product name:** KCGM IRON SULPHIDE CONCENTRATE

**Recommended use:** Mining Industry. Concentrated iron sulphide ore for the refining process.


**Supplier:** Kalgoorlie Consolidated Gold Mines (KCGM)
**ABN:** 43 092 832 892
**Street Address:** 1 Black Street
Kalgoorlie,
WA, 6433
Australia
**Telephone:** +61 8 9022 154


**Emergency Telephone number: +61 8 9022 154**

## 2. HAZARDS IDENTIFICATION

**This material is hazardous according to the criteria of Safe Work Australia GHS 7.**

**Signal Word**
Danger

**Hazard Classifications**
Carcinogenicity - Category 1A
Specific Target Organ Toxicity (Repeated Exposure) - Category 2
Acute Hazard to the Aquatic Environment - Category 2
Chronic Hazard to the Aquatic Environment - Category 3

**Hazard Statements**

| | |
|---|---|
| H350 | May cause cancer. |
| H373 | May cause damage to organs through prolonged or repeated exposure. |
| H401 | Toxic to aquatic life. |
| H412 | Harmful to aquatic life with long lasting effects. |

**Prevention Precautionary Statements**

| | |
|---|---|
| P102 | Keep out of reach of children. |
| P103 | Read carefully and follow all instructions. |
| P202 | Do not handle until all safety precautions have been read and understood. |
| P260 | Do not breathe dust, fume, gas, mist, vapours or spray. |
| P273 | Avoid release to the environment. |
| P280 | Wear protective gloves/protective clothing including eye/face protection. |

**Response Precautionary Statements**

| | |
|---|---|
| P101 | If medical advice is needed, have product container or label at hand. |
| P308+P313 | IF exposed or concerned: Get medical advice/attention. |
| P314 | Get medical advice/attention if you feel unwell. |

**Storage Precautionary Statement**

| | |
|---|---|
| P405 | Store locked up. |

**Disposal Precautionary Statement**

P501 Dispose of contents/container in accordance with local, regional, national and international regulations.

**Poison Schedule:** Not Applicable

**DANGEROUS GOOD CLASSIFICATION**

Not classified as Dangerous Goods by the criteria of the "Australian Code for the Transport of Dangerous Goods by Road & Rail" and the "New Zealand NZS5433: Transport of Dangerous Goods on Land".

## 3. COMPOSITION INFORMATION

| CHEMICAL ENTITY | CAS NO | PROPORTION |
|---|---|---|
| Pyrite (FeS2) | 1309-36-0 | >60 % (w/w) |
| Calcium Carbonate | 13397-26-7 | 1 - 10 % (w/v) |
| Dolomite (CaMg(CO3)2) | 16389-88-1 | 1 - 10 % (w/w) |
| Mica group minerals | 12001-26-2 | 1 - 10 % (w/w) |
| Silica, crystalline (quartz) ([RCS]>0.1%) | 14808-60-7 | 1 - 10 % (w/w) |
| Sodium aluminium trisilicon octaoxide (Albite) | 12244-10-9 | 1 - 10 % (w/w) |
| Sodium chloride (NaCl) | 7647-14-5 | 1 - 10 % (w/w) |
| Arsenopyrite | 1303-18-0 | <1 % (w/w) |
| Zinc sulfide (ZnS) | 1314-98-3 | <1 % (w/w) |
| Ingredients determined to be Non-Hazardous | | Balance |
| | | 100% |

## 4. FIRST AID MEASURES

If poisoning occurs, contact a doctor or Poisons Information Centre (Phone Australia 131 126, New Zealand 0800 764 766).

**Inhalation:** Remove victim from exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. Seek medical advice if effects persist.

**Skin Contact:** If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. If swelling, redness, blistering or irritation occurs seek medical assistance.

**Eye contact:** If in eyes wash out immediately with water. In all cases of eye contamination it is a sensible precaution to seek medical advice.

**Ingestion:** Rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water to drink. Never give anything by the mouth to an unconscious patient. If vomiting occurs give further water. Seek medical advice.

**PPE for First Aiders:** Wear safety shoes, overalls, gloves, safety glasses, dust mask. Available information suggests that gloves made from nitrile rubber should be suitable for intermittent contact. However, due to variations in glove construction and local conditions, the user should make a final assessment. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storing or re-using.

**Notes to physician:** Treat symptomatically.

## 5. FIRE FIGHTING MEASURES

**Hazchem Code:** Not applicable.

**Suitable extinguishing media:** If material is involved in a fire use water fog (or if unavailable fine water spray), alcohol resistant foam, standard foam, dry agent (carbon dioxide, dry chemical powder).

**Specific hazards:** Non-combustible material.

**Fire fighting further advice:** Not applicable.

## 6. ACCIDENTAL RELEASE MEASURES

**SMALL SPILLS**
Wear protective equipment to prevent skin and eye contamination. Avoid inhalation of vapours or dust. Wipe up with absorbent (clean rag or paper towels). Collect and seal in properly labelled containers or drums for disposal.

**LARGE SPILLS**
Clear area of all unprotected personnel. Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contamination and the inhalation of dust. Work up wind or increase ventilation. Cover with damp absorbent (inert material, sand or soil). Sweep or vacuum up, but avoid generating dust. Collect and seal in properly labelled containers or drums for disposal. If contamination of crops, sewers or waterways has occurred advise local emergency services.

**Dangerous Goods - Initial Emergency Response Guide No:** Not applicable

## 7. HANDLING AND STORAGE

**Handling:** Avoid eye contact and skin contact. Avoid inhalation of dust.

**Storage:** Store in a cool, dry, well-ventilated place and out of direct sunlight. Store away from foodstuffs. Store away from incompatible materials described in Section 10. Store away from sources of heat and/or ignition. Store locked up. Keep container standing upright. Keep containers closed when not in use - check regularly for spills.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**National occupational exposure limits:**

| | TWA | | STEL | | NOTICES |
|---|---|---|---|---|---|
| | ppm | mg/m3 | ppm | mg/m3 | |
| Mica | - | 2.5 (inspirable) | - | - | - |
| Quartz (respirable dust) | - | 0.05 | - | - | Carc. 1A |
| Silica Crystalline - Quartz (respirable dust) | - | 0.05 | - | - | Carc. 1A |

As published by Safe Work Australia.

TWA - The time-weighted average airborne concentration over an eight-hour working day, for a five-day working week over an entire working life.

STEL (Short Term Exposure Limit) - the average airborne concentration over a 15 minute period which should not be exceeded at any time during a normal eight-hour workday.

These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

If the directions for use on the product label are followed, exposure of individuals using the product should not exceed the above standard. The standard was created for workers who are routinely, potentially exposed during product manufacture.

**Biological Limit Values:** As per the "National Model Regulations for the Control of Workplace Hazardous Substances (Safe Work Australia)" the ingredients in this material do not have a Biological Limit Allocated.

**Engineering Measures:** Ensure ventilation is adequate to maintain air concentrations below Exposure Standards. Use only in well ventilated areas. Avoid generating and inhaling dusts. Use with local exhaust ventilation or while wearing dust mask.

**Personal Protection Equipment:** SAFETY SHOES, OVERALLS, GLOVES, SAFETY GLASSES, DUST MASK.

Personal protective equipment (PPE) must be suitable for the nature of the work and any hazard associated with the work as identified by the risk assessment conducted.

Wear safety shoes, overalls, gloves, safety glasses, dust mask. Available information suggests that gloves made from nitrile rubber should be suitable for intermittent contact. However, due to variations in glove construction and local conditions, the user should make a final assessment. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storing or re-using.

**Hygiene measures:** Keep away from food, drink and animal feeding stuffs. When using do not eat, drink or smoke. Wash hands prior to eating, drinking or smoking. Avoid contact with clothing. Avoid eye contact and skin contact. Avoid inhalation of dust. Ensure that eyewash stations and safety showers are close to the workstation location.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **Form:** | Solid |
| **Colour:** | Dark-brown / green |
| **Odour:** | Odourless |

| | |
|---|---|
| **Solubility:** | Insoluble in water |
| **Specific Gravity:** | 3.5 - 4.0 |
| **Relative Vapour Density (air=1):** | N App |
| **Vapour Pressure:** | N App |
| **Flash Point (°C):** | N App |
| **Explosion/Flammability Limits:** | N App |
| **Autoignition Temperature (°C):** | N App |
| **Melting Point/Range (°C):** | N App |
| **Boiling Point/Range (°C):** | N App |
| **pH:** | 8.0 - 10.5 (10% Aqu Soln) |
| **Viscosity:** | N App |
| **Total VOC (g/Litre):** | N Av |

(Typical values only - consult specification sheet)
N Av = Not available, N App = Not applicable

## 10. STABILITY AND REACTIVITY

**Chemical stability:** This material is thermally stable when stored and used as directed.

**Conditions to avoid:** Elevated temperatures and sources of ignition.

**Incompatible materials:** Oxidising agents.

**Hazardous decomposition products:** Oxides of carbon and nitrogen, smoke and other toxic fumes.

**Hazardous reactions:** No known hazardous reactions.

## 11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

**Acute Effects**

**Inhalation:** Material may be an irritant to mucous membranes and respiratory tract.

**Skin contact:** Contact with skin may result in irritation.

**Ingestion:** Swallowing can result in nausea, vomiting and irritation of the gastrointestinal tract.

**Eye contact:** May be an eye irritant. Exposure to the dust may cause discomfort due to particulate nature. May cause physical irritation to the eyes.

**Acute toxicity**

**Inhalation:** This material has been classified as not hazardous for acute inhalation exposure. Acute toxicity estimate (based on ingredients): $LC_{50}$ > 5.0 mg/L for dust.

**Skin contact:** This material has been classified as not hazardous for acute dermal exposure. Acute toxicity estimate (based on ingredients): $LD_{50}$ > 2,000 mg/Kg bw

**Ingestion:** This material has been classified as not hazardous for acute ingestion exposure. Acute toxicity estimate (based on ingredients): $LD_{50}$ > 2,000 mg/Kg bw

**Corrosion/Irritancy:** Eye: this material has been classified as not corrosive or irritating to eyes. Skin: this material has been classified as not corrosive or irritating to skin.

**Sensitisation:** Inhalation: this material has been classified as not a respiratory sensitiser. Skin: this material has been classified as not a skin sensitiser.

**Aspiration hazard:** This material has been classified as not an aspiration hazard.

**Specific target organ toxicity (single exposure):** This material has been classified as not a specific hazard to target organs by a single exposure.

**Chronic Toxicity**

**Mutagenicity:** This material has been classified as not a mutagen.

**Carcinogenicity:** This material has been classified as a Category 1A Hazard.

**Reproductive toxicity (including via lactation):** This material has been classified as not a reproductive toxicant.

**Specific target organ toxicity (repeat exposure):** This material has been classified as a Category 2 Hazard.

## 12. ECOLOGICAL INFORMATION

Avoid contaminating waterways.

**Acute aquatic hazard:** This material has been classified as a Category Acute 2 Hazard. Acute toxicity estimate (based on ingredients): > 1 ≤ 10 mg/L

**Long-term aquatic hazard:** This material has been classified as a Category Chronic 3 Hazard. Non-rapidly or rapidly degradable substance for which there are adequate chronic toxicity data available OR in the absence of chronic toxicity data, Acute toxicity estimate (based on ingredients): 10 - 100 mg/L, where the substance is not rapidly degradable and/or BCF ≥ 500 and/or log $K_{ow}$ ≥ 4.

**Ecotoxicity:** No information available.

**Persistence and degradability:** No information available.

**Bioaccumulative potential:** No information available.

**Mobility:** No information available.

## 13. DISPOSAL CONSIDERATIONS

Persons conducting disposal, recycling or reclamation activities should ensure that appropriate personal protection equipment is used, see "Section 8. Exposure Controls and Personal Protection" of this SDS.

If possible material and its container should be recycled. If material or container cannot be recycled, dispose in accordance with local, regional, national and international Regulations.

## 14. TRANSPORT INFORMATION

**ROAD AND RAIL TRANSPORT**
Not classified as Dangerous Goods by the criteria of the "Australian Code for the Transport of Dangerous Goods by Road & Rail" and the "New Zealand NZS5433: Transport of Dangerous Goods on Land".

**MARINE TRANSPORT**
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea.

International Convention for the Prevention of Pollution from Ships (MARPOL)
- Annex V - (Solid Bulk Cargo Residues): Classified as Not Harmful to the Marine Environment (non-HME).

International Maritime Solid Bulk Cargoes Code (IMSBC)
- Classified as a Mineral Concentrate Group A

**AIR TRANSPORT**
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air.

## 15. REGULATORY INFORMATION

**This material is not subject to the following international agreements:**
Montreal Protocol (Ozone depleting substances)
The Stockholm Convention (Persistent Organic Pollutants)
The Rotterdam Convention (Prior Informed Consent)

Basel Convention (Hazardous Waste)

**This material is subject to the following international agreements:**

International Convention for the Prevention of Pollution from Ships (MARPOL)
- Annex V - (Solid Bulk Cargo Residues): Classified as Not Harmful to the Marine Environment (non-HME).

International Maritime Solid Bulk Cargoes Code (IMSBC)
- Classified as a Mineral Concentrate Group A

**This material/constituent(s) is covered by the following requirements:**

The Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) established under the Therapeutic Goods Act (Commonwealth): Not Applicable.

AICIS Status: All components of this product are listed on or exempt from the Australian Inventory of Industrial Chemicals (AIIC).

## 16. OTHER INFORMATION

Reason for issue: Revised

This Safety Data Sheet has been prepared by Chemical Data Services Pty Ltd on behalf of its client.

Safety Data Sheets are updated frequently. Please ensure that you have a current copy.

This information was prepared in good faith from the best information available at the time of issue. It is based on the present level of research and to this extent we believe it is accurate. However, no guarantee of accuracy is made or implied and since conditions of use are beyond our control, all information relevant to usage is offered without warranty. The manufacturer will not be held responsible for any unauthorised use of this information or for any modified or altered versions.

If clarification or further information is needed to ensure that an appropriate assessment can be made, the user should contact this company.

Our responsibility for product as sold is subject to our standard terms and conditions, a copy of which is sent to our customers and is also available upon request.

# Result Sheet

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HRL Technology Group Pty Ltd
ABN 89 609 887 327

Unit 4, Level 1, 677 Springvale Road
Mulgrave Victoria 3170
AUSTRALIA

Date: 20th May 2025 File No. 61240235 Report No. 250563-1

To: Name [redacted]
Company Davoren Environmental Pty Ltd
Address [redacted]
Fax No. Tel No.

From: Name [redacted] Tel No. 03 9565 9859

Number of pages including this page: 13

## ANALYSIS OF KCGM IRON SULPHIDE CONCENTRATE

Signed: [redacted] ate: 20/05/2025 Approve[redacted] ate: 20/05/2025

Team Leader - Certification Business Unit Leader - LATS

Contents

## 1. INTRODUCTION

A sample identified as KCGM Iron Sulphide Concentrate was received by HRL Technology Group Pty Ltd on the 07/05/2025. HRL were subcontracted by Davoren Environmental Pty Ltd to conduct various testing of the KCGM Iron Sulphide Concentrate. The following analysis were requested:

1. Chemical Characterisation for a suite of 37 elements.
2. Particle Size Distribution (PSD) by laser diffraction.
3. EPA testing according to Western Australia Landfill Waste Classification and Waste Definition 1996

## 2. CHEMICAL CHARACTERISATION

### 2.1 Methodology

A sub-sample was taken from the original sample and ground to a top size of nominally 100 microns to improve homogeneity, prior to analysis.

Chemical characterisation of 37 elements was performed using two different methods. Hot block acid digestion according to I.S EN ISO 16968:2015 and acid digestion followed by fusion procedure. The detection method applied was Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

### 2.2 Results

The KCGM Iron Sulphide Concentrate sample was chemically characterised and the concentration of 37 elements are reported in **Table 1**.

**Table 1:** Chemical Characterisation Analysis for KCGM Iron Sulphide Concentrate Sample

| **Sample ID: HRL LIMS Nº. 250563-1 KCGM Iron Sulphide Concentrate** | | | |
|---|---|---|---|
| **ELEMENT** | **LIMIT OF QUANTITATION (LOQ)** | **UNIT OF MEASURE** | **CONCENTRATION** |
| Ag | 0.1 | mg/kg (dry basis) | 17 |
| Al | 10 | mg/kg (dry basis) | 15890 |
| As | 4 | mg/kg (dry basis) | 1186 |
| Au | 20 | mg/kg (dry basis) | 40 |
| B | 0.08 | mg/kg (dry basis) | 13 |
| Ba | 0.6 | mg/kg (dry basis) | 63 |
| Be | 0.1 | mg/kg (dry basis) | 0.4 |
| Bi | 1 | mg/kg (dry basis) | <1 |
| Ca | 10 | mg/kg (dry basis) | 15195 |
| Cd | 0.2 | mg/kg (dry basis) | 40 |
| Ce | 6 | mg/kg (dry basis) | 17 |
| Co | 1 | mg/kg (dry basis) | 546 |
| Cr | 1 | mg/kg (dry basis) | 170 |
| Cu | 5 | mg/kg (dry basis) | 1733 |
| Fe | 2 | mg/kg (dry basis) | 348150 |

| Sample ID: HRL LIMS Nº. 250563-1 KCGM Iron Sulphide Concentrate | | | |
|---|---|---|---|
| ELEMENT | LIMIT OF QUANTITATION (LOQ) | UNIT OF MEASURE | CONCENTRATION |
| Hg | 0.01 | mg/kg (dry basis) | 9.5 |
| K | 10 | mg/kg (dry basis) | 5240 |
| Li | 0.6 | mg/kg (dry basis) | 7 |
| Mg | 10 | mg/kg (dry basis) | 6906 |
| Mn | 10 | mg/kg (dry basis) | 573 |
| Mo | 0.1 | mg/kg (dry basis) | 51 |
| Na | 10 | mg/kg (dry basis) | 6425 |
| Ni | 0.1 | mg/kg (dry basis) | 600 |
| P | 10 | mg/kg (dry basis) | 263 |
| Pb | 1 | mg/kg (dry basis) | 145 |
| Pd | 30 | mg/kg (dry basis) | <30 |
| S | 10 | mg/kg (dry basis) | 364290 |
| Sb | 0.2 | mg/kg (dry basis) | 156 |
| Se | 0.6 | mg/kg (dry basis) | 51 |
| Si | 10 | mg/kg (dry basis) | 58900 |
| Sn | 0.7 | mg/kg (dry basis) | 3 |
| Sr | 1 | mg/kg (dry basis) | 44 |
| Ti | 10 | mg/kg (dry basis) | 4379 |
| Tl | 0.8 | mg/kg (dry basis) | 2 |
| V | 0.2 | mg/kg (dry basis) | 112 |
| Zn | 0.2 | mg/kg (dry basis) | 2234 |
| Zr | 0.2 | mg/kg (dry basis) | 72 |

## 3. PARTICLE SIZE DISTRIBUTION

### 3.1 Methodology

Laser PSD analysis using light diffraction measurements was used to determine the particle size distribution.

### 3.2 Results

The data is available as an attached spread sheet (See **Appendix 1**). The particle size distribution is shown in **Figure 1** below.

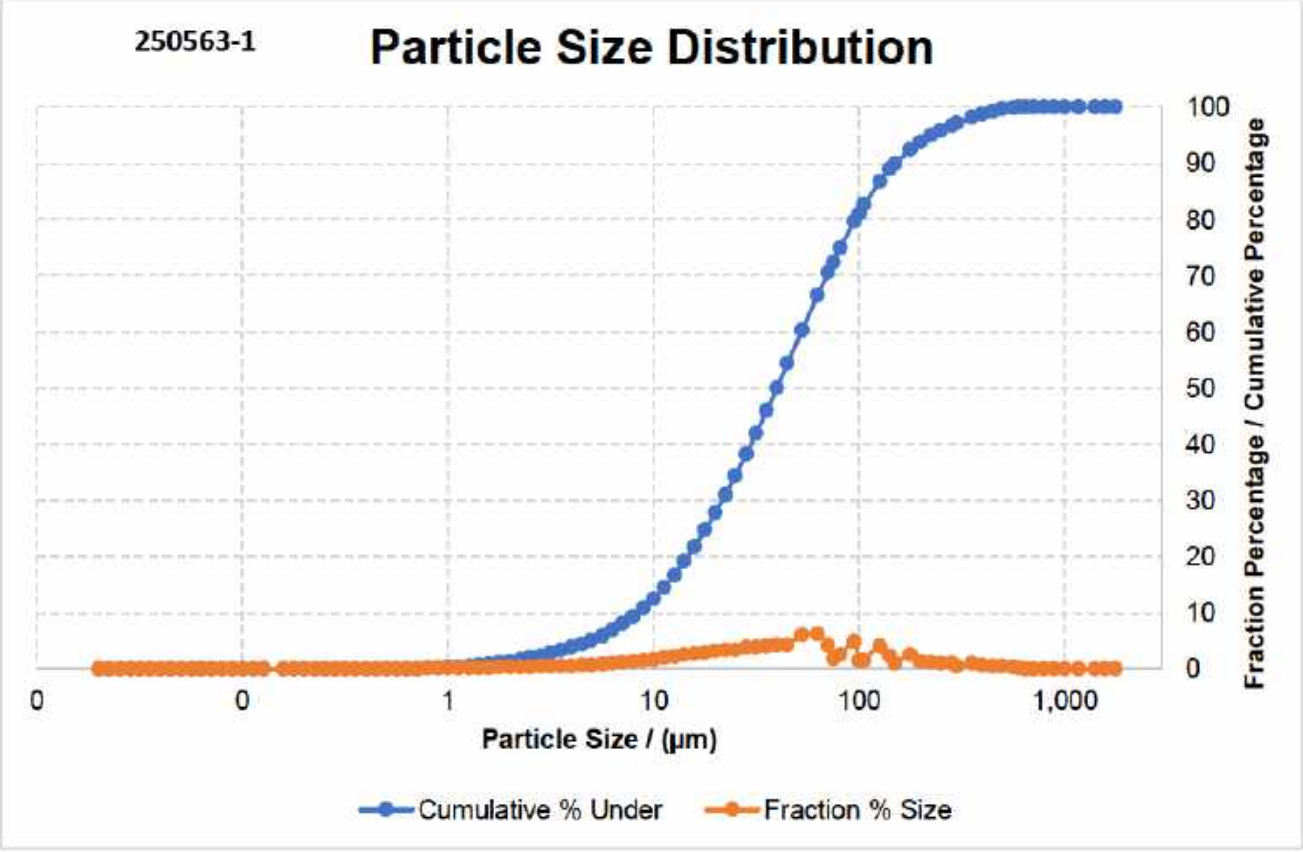


**Figure 1**: Particle Size Distribution of KCGM Iron Sulphide Concentrate Sample

## 4. EPA TESTING

All tests were performed in accordance with Landfill Waste Classification and Waste Definition 1996 by the Government of Western Australia, Department of Water and Environmental Regulation.

### 4.1 Total Metals and Metalloids

#### 4.1.1. Methodology

Total concentration of metals and metalloids analysis was performed according to EPA Method 200.2, Revision 2.8. The detection method applied was ICP-OES and cold vapour AAS.

Hexavalent Chromium (Cr(VI)) was determined using EPA Method 3060A and Method 7196A.

#### 4.1.2 Results

The total metals and metalloids results are present in Table 2.

Table 2: Total Metals and Metalloids Results for KCGM Iron Sulphide Concentrate Sample

| Sample ID: HRL LIMS Nº. 250563-1 KCGM Iron Sulphide Concentrate | | | |
|---|---|---|---|
| ELEMENT | LIMIT OF QUANTITATION (LOQ) | UNIT OF MEASURE | CONCENTRATION |
| Ag | 0.1 | mg/kg (dry basis) | 17 |
| As | 4 | mg/kg (dry basis) | 1133 |
| Be | 0.1 | mg/kg (dry basis) | 0.04 |
| Cd | 0.2 | mg/kg (dry basis) | 40 |
| Cr (VI) | 0.01 | mg/kg (dry basis) | <0.01 |
| Hg | 0.01 | mg/kg (dry basis) | 9.2 |
| Mo | 0.1 | mg/kg (dry basis) | 16 |
| Ni | 0.1 | mg/kg (dry basis) | 578 |
| Pb | 1 | mg/kg (dry basis) | 135 |
| Se | 0.6 | mg/kg (dry basis) | 27 |
| Al, Ba, B, Co, Cu, Mn, V and Zn | NA | % by weight | 0.57 |

### 4.2 Leachable Metals

#### 4.2.1 Methodology

Leachates were prepared according to AS 4439.3. At the client's request, the leaching fluids were reagent water and acetate buffer, pH 5.0.

Leachable metals were determined by ICP-OES and cold vapour AAS.

Leachable Hexavalent Chromium (Cr(VI)) was not determined as the Hexavalent Chromium was not detected in the sample.

#### 4.2.2 Results

Leachable metals results using reagent water as a leaching fluid are presented in **Table 3**.

Leachable metals results using acetate buffer pH 5.0 as a leaching fluid are presented in **Table 4**.

**Table 3:** Leachable Metals Results for KCGM Iron Sulphide Concentrate Sample, Reagent Water

| **Sample ID: HRL LIMS Nº. 250471-01 KCGM Iron Sulphide Concentrate** | | | |
|---|---|---|---|
| **ELEMENT** | **LIMIT OF QUANTITATION (LOQ)** | **UNIT OF MEASURE** | **CONCENTRATION** |
| Ag | 0.02 | mg/L | <0.02 |
| As | 0.02 | mg/L | <0.02 |
| Be | 0.01 | mg/L | <0.01 |
| Cd | 0.01 | mg/L | <0.01 |
| Cr (VI) | 0.01 | mg/L | <0.01 |
| Hg | 0.001 | mg/L | <0.001 |
| Mo | 0.01 | mg/L | 0.01 |
| Ni | 0.01 | mg/L | <0.01 |
| Pb | 0.02 | mg/L | <0.02 |
| Se | 0.02 | mg/L | <0.02 |
| Al, Ba, B, Co, Cu, Mn, V and Zn | NA | % by weight | NA |

**Table 4:** Leachable Metals Results for KCGM Iron Sulphide Concentrate Sample, Acetate Buffer pH 5.0

| Sample ID: HRL LIMS Nº. 250471-01 KCGM Iron Sulphide Concentrate | | | |
|---|---|---|---|
| **ELEMENT** | **LIMIT OF QUANTITATION (LOQ)** | **UNIT OF MEASURE** | **CONCENTRATION** |
| Ag | 0.02 | mg/L | <0.02 |
| As | 0.02 | mg/L | <0.02 |
| Be | 0.01 | mg/L | <0.01 |
| Cd | 0.01 | mg/L | <0.01 |
| Cr (VI) | 0.01 | mg/L | <0.01 |
| Hg | 0.001 | mg/L | <0.001 |
| Mo | 0.01 | mg/L | <0.01 |
| Ni | 0.01 | mg/L | 0.11 |
| Pb | 0.02 | mg/L | 0.03 |
| Se | 0.02 | mg/L | <0.02 |
| Al, Ba, B, Co, Cu, Mn, V and Zn | NA | % by weight | NA |

# Appendix 1

| Size (µm) | Cumulative % Under | Fraction % Size |
|---|---|---|
| 0.020 | 0.000 | 0.000 |
| 0.022 | 0.000 | 0.000 |
| 0.025 | 0.000 | 0.000 |
| 0.028 | 0.000 | 0.000 |
| 0.032 | 0.000 | 0.000 |
| 0.036 | 0.000 | 0.000 |
| 0.040 | 0.000 | 0.000 |
| 0.045 | 0.000 | 0.000 |
| 0.050 | 0.000 | 0.000 |
| 0.056 | 0.000 | 0.000 |
| 0.063 | 0.000 | 0.000 |
| 0.071 | 0.000 | 0.000 |
| 0.080 | 0.000 | 0.000 |
| 0.089 | 0.000 | 0.000 |
| 0.100 | 0.000 | 0.000 |
| 0.112 | 0.000 | 0.000 |
| 0.126 | 0.000 | 0.000 |
| 0.159 | 0.000 | 0.000 |
| 0.178 | 0.000 | 0.000 |
| 0.200 | 0.000 | 0.000 |
| 0.224 | 0.000 | 0.000 |
| 0.252 | 0.000 | 0.000 |
| 0.283 | 0.000 | 0.000 |
| 0.317 | 0.000 | 0.000 |
| 0.356 | 0.000 | 0.000 |
| 0.399 | 0.000 | 0.000 |
| 0.448 | 0.000 | 0.000 |
| 0.502 | 0.000 | 0.000 |
| 0.564 | 0.000 | 0.000 |
| 0.632 | 0.000 | 0.000 |
| 0.710 | 0.028 | 0.028 |
| 0.796 | 0.086 | 0.059 |
| 0.893 | 0.152 | 0.066 |
| 1.000 | 0.233 | 0.081 |
| 1.125 | 0.340 | 0.107 |
| 1.262 | 0.470 | 0.130 |
| 1.416 | 0.631 | 0.161 |
| 1.589 | 0.824 | 0.193 |
| 1.783 | 1.054 | 0.229 |
| 2.000 | 1.320 | 0.267 |
| 2.244 | 1.626 | 0.305 |
| 2.500 | 1.948 | 0.322 |
| 2.825 | 2.356 | 0.408 |

| | | |
|---|---|---|
| 3.170 | 2.785 | 0.430 |
| 3.557 | 3.264 | 0.479 |
| 3.991 | 3.803 | 0.538 |
| 4.477 | 4.413 | 0.610 |
| 5.000 | 5.083 | 0.670 |
| 5.637 | 5.927 | 0.844 |
| 6.325 | 6.876 | 0.949 |
| 7.096 | 7.987 | 1.112 |
| 7.962 | 9.284 | 1.297 |
| 8.934 | 10.790 | 1.506 |
| 10.000 | 12.479 | 1.689 |
| 11.247 | 14.481 | 2.001 |
| 12.619 | 16.679 | 2.198 |
| 14.159 | 19.111 | 2.433 |
| 15.887 | 21.772 | 2.660 |
| 17.825 | 24.649 | 2.877 |
| 20.000 | 27.736 | 3.087 |
| 22.440 | 31.021 | 3.284 |
| 25.000 | 34.275 | 3.255 |
| 28.251 | 38.145 | 3.870 |
| 31.698 | 41.956 | 3.812 |
| 35.566 | 45.909 | 3.953 |
| 40.000 | 50.061 | 4.152 |
| 45.000 | 54.309 | 4.247 |
| 53.000 | 60.261 | 5.952 |
| 63.000 | 66.460 | 6.200 |
| 70.963 | 70.573 | 4.112 |
| 75.000 | 72.420 | 1.847 |
| 81.000 | 74.903 | 2.484 |
| 95.000 | 79.674 | 4.771 |
| 100.000 | 81.088 | 1.414 |
| 106.000 | 82.617 | 1.529 |
| 126.191 | 86.677 | 4.061 |
| 141.589 | 88.930 | 2.253 |
| 150.000 | 89.931 | 1.001 |
| 178.250 | 92.466 | 2.535 |
| 200.000 | 93.816 | 1.350 |
| 224.404 | 94.946 | 1.130 |
| 249.999 | 95.849 | 0.903 |
| 282.508 | 96.736 | 0.887 |
| 300.000 | 97.132 | 0.396 |
| 355.656 | 98.144 | 1.012 |
| 399.052 | 98.745 | 0.600 |
| 447.744 | 99.257 | 0.512 |
| 500.000 | 99.646 | 0.389 |
| 563.677 | 99.948 | 0.302 |
| 600.000 | 100.000 | 0.052 |

| | | |
|---|---|---|
| 650.000 | 100.000 | 0.000 |
| 710.000 | 100.000 | 0.000 |
| 796.214 | 100.000 | 0.000 |
| 893.367 | 100.000 | 0.000 |
| 1000.000 | 100.000 | 0.000 |
| 1179.999 | 100.000 | 0.000 |
| 1180.000 | 100.000 | 0.000 |
| 1415.892 | 100.000 | 0.000 |
| 1588.656 | 100.000 | 0.000 |
| 1782.502 | 100.000 | 0.000 |
| 2000.000 | 100.000 | 0.000 |

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# TBS Report 12160

## Davoren Environmental Pty

## Dust Extinction Moisture Testing: Iron Sulphide

| | | | |
|---|---|---|---|
| **To:** | Davoren Environmental Pty | **Date:** | 22/05/2025 |
| **Attention:** | Maria Davoren | **Pages:** | 5 |
| **Email:** | [redacted] | **Revision:** | 00 |

| Task | Person | Role | Date |
|---|---|---|---|
| **Authored:** | [redacted] | Engineering Manager | 22/05/2025 |
| **Reviewed:** | | Mechanical Engineer | 21/05/2025 |

# DISCLAIMER

Users of this report are invited to contact TUNRA Bulk Solids if clarification of any aspect is required. The test results presented are for a client supplied bulk material sample/s. Should the material handled in practice vary from this test sample then the results in this report may be far from optimal. In addition, any extrapolation of the data and/or recommendations to situations other than those for which they were specifically intended without confirmation by TUNRA Bulk Solids may lead to erroneous conclusions. The contents of this report may not be reproduced without the consent of the client; and then only in full. This investigation was performed using the Bulk Solids Handling Laboratories of TUNRA Bulk Solids Handling Research Associates and the Centre for Bulk Solids & Particulate Technologies at The University of Newcastle.

[redacted]

*Engineering Manager, TUNRA Bulk Solids*

[redacted]

# 1 EXECUTIVE SUMMARY

Davoren Environmental Pty has commissioned TUNRA Bulk Solids to conduct testing to determine the Dust Extinction Moisture (DEM) of an Iron Sulphide sample.

# 2 TEST PROCEDURE

## 2.1 Dust Extinction Moisture Test Method

The Dust Extinction Moisture (DEM) was determined using the test device described by Australian Standard AS 4156.6-2000. This standard was written specifically for coal but has been utilised for other bulk materials by modifying the quantity of sample placed in the test rig. The standard calls for 1 kg of coal and this equates to approximately 1 litre of test sample. In applying the method to higher density bulk materials TUNRA maintains a test volume of approximately 1 litre, where the dust number determination presented in Equation 1 provides for a normalisation of mass. AS 4156.6-2000 should be referred to for a complete explanation of the test procedure, however, a concise description is as follows. The test rig shown in Figure 1 consists of a rotating drum in which the sample of material to be tested, at a pre-measured moisture level, is placed. The drum is rotated at a speed of 29 RPM for a period of 10 minutes while an air flow rate of 175 L/min is drawn through a hole in the drum lid, through a hollow drive shaft and into a paper filter bag which collects the dust generated in the drum. Testing is performed in a controlled environment at a temperature of 20±2°C and relative humidity of 63±2%RH.

**Figure 1** Dust extinction moisture test rig.

The weight of the filter bag is measured before and after the test to determine the quantity of dust collected. A dust number is then calculated according to Equation 1.

$$Dust\ Number = \frac{M_b - M_a}{M_s} \times 10^5 \quad (1)$$

Where

| | | |
|---|---|---|
| $M_b$ | = | Mass of filter bag and dust (grams) |
| $M_a$ | = | Mass of filter bag (grams) |
| $M_s$ | = | Mass of sample in drum (grams) |

The test work is conducted on a number of samples over a range of moistures and the dust numbers obtained are plotted on a log-linear graph. The Dust Extinction Moisture (DEM) is determined by the intersection of a regression of relevant dust-moisture data points through a dust number of 10. The actual DEM value is only totally representative if conditions (air speed, material stream characteristics etc.) are identical to those inside the test rig. However, the observed relationship between dust and moisture may be consulted to determine the sensitivity of the material to dust control by addition of moisture.

## 3 TEST RESULTS

### 3.1 Dust Extinction Moisture Test Results

DEM testing yielded the dust moisture curve presented in Figure 2. The relationship indicates how much moisture may be required to improve dust control during dust generating events – for example, those occurring at transfer points or during ship loading.

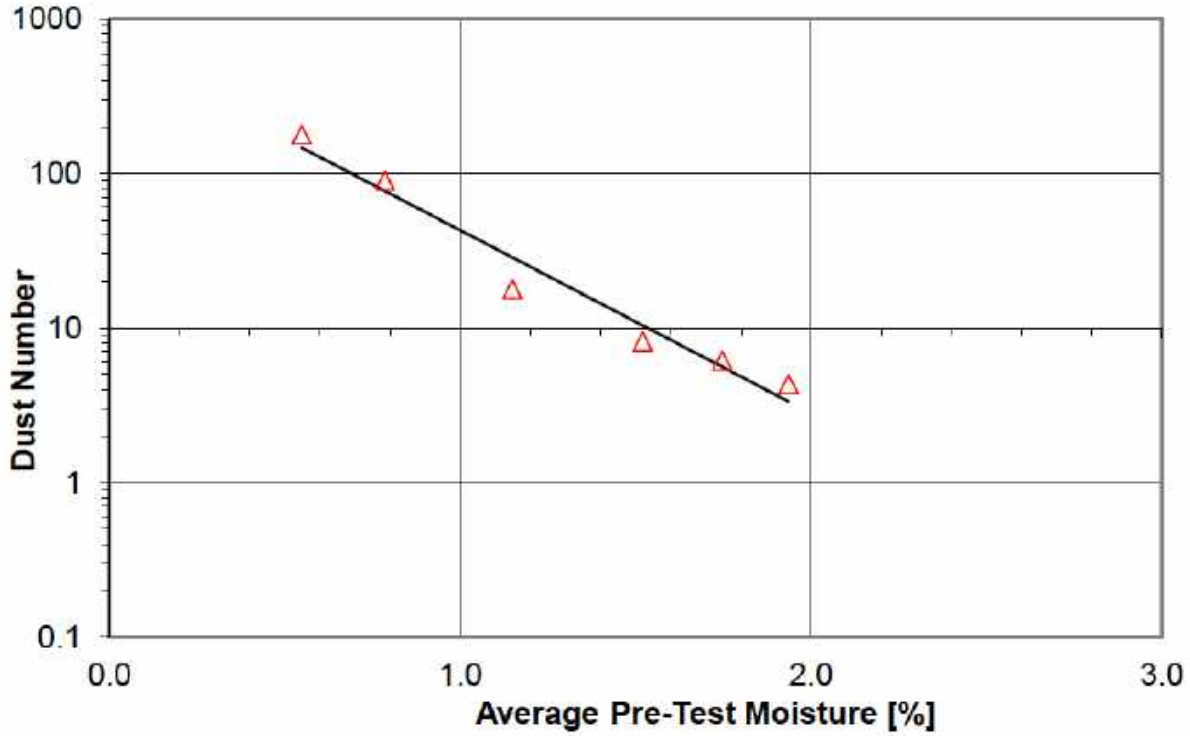


**Figure 2** Dust-moisture relationship.

The DEM value determined for the product is listed in Table 1 and is determined as the intercept of the regression of relevant dust-moisture data points with a dust number of 10 - as per AS 4156.6.

**Table 1** Dust Extinction Moisture

| Sample | DEM Moisture (% Wet basis) |
|---|---|
| Iron Sulphide | 1.53 |

The dust numbers and moisture content relationships only apply to the Iron Sulphide sample tested. A change in particle size distribution (for example through handling or processing) will change the relationship and results.