

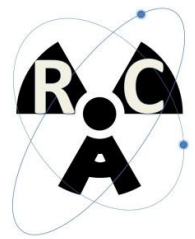
Attachment 8 RCA (2025) Tronox Cooljarloo Osprey Extension Radiation Impact Assessment

Cooljarloo Mineral Sands Mine - Osprey and GR6N Extension

EPBC Act Referral

Tronox Management Pty Ltd

SLR Project No.: 675.073161.00001

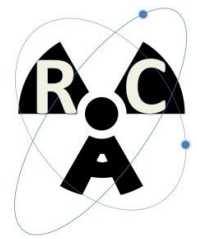


Tronox

Cooljarloo Osprey Extension

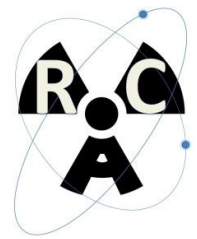
Radiation Impact Assessment

September 2025

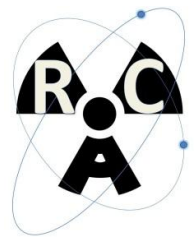


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GLOSSARY

Activity: The rate at which a radionuclide decays, expressed in becquerels (Bq), where 1 Bq equals one disintegration per second.

ALARA: "As Low As Reasonably Achievable" - a principle of radiation protection to minimize radiation doses and releases of radioactive materials.

Becquerel (Bq): The SI unit of radioactivity, representing one disintegration per second.

Contaminated Equipment: Equipment that has radioactive material on its surface or embedded within it.

Dose: A measure of radiation absorbed by tissue, expressed in sieverts (Sv).

Dose Limit: The maximum permissible radiation dose established by regulatory authorities.

Dust Suppression: Measures used to minimize airborne dust generation to reduce radiological and environmental impacts.

Gamma Radiation: High-energy electromagnetic radiation emitted during radioactive decay.

Gray (Gy): The SI unit of absorbed dose of radiation.

Groundwater Monitoring: Regular testing of groundwater to detect the presence and concentration of radionuclides.

Heavy Mineral Concentrate (HMC): A concentrate produced from mineral sands containing valuable heavy minerals such as zircon and rutile.

ERICA Tool: Environmental Risks from Ionising Contaminants Assessment and Management Tool used for assessing radiation risks to non-human biota.

Mining Code (ARPANSA): Australian Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing.

Mitigation Measures: Strategies implemented to prevent or minimize radiological risks and impacts.

Occupancy Factor: The fraction of time an individual is assumed to spend in a particular location for dose assessment purposes.

Radionuclide: An unstable isotope of an element that decays and emits ionizing radiation.

Radon (Rn²²⁰/Thoron): A radioactive gas produced from the decay of thorium²³².

Radon (Rn²²²): A naturally occurring radioactive gas produced from the decay of uranium²³⁸.

Radiation Management Plan (RMP): A document outlining procedures for safely managing radiation risks associated with a project.

Radiation Monitoring: The systematic measurement of radiation levels in the environment or workplace.

RESRAD: A computer code used to estimate radiation doses to individuals under various exposure scenarios.

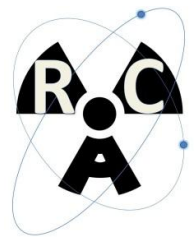
Seepage: The movement of liquids, potentially carrying radionuclides, through containment barriers.

Secular Equilibrium: A state where the activity concentrations of a parent radionuclide and its decay products are equal due to the long half-life of the parent.

Sievert (Sv): The SI unit of effective dose of radiation, accounting for biological effects.

Tailings: Residue materials remaining after the valuable fractions of an ore have been extracted.

Transport Route Study Area: The area assessed for potential radiological impacts during transport of materials.



EXECUTIVE SUMMARY

This Radiation Impact Assessment has been prepared to evaluate the potential radiological impacts associated with the proposed extension of the existing Cooljarloo Mineral Sands Mine into the Osprey mineral sands proposed mining area. The assessment considers impacts from the mining, handling, processing, transport, and disposal of materials containing naturally occurring radioactive materials (NORM), focusing on both human and non-human biota.

The assessment was undertaken in accordance with the requirements of the Radiation Safety Act 1975 (WA), the Environment Protection and Biodiversity Conservation Act 1999 (Cwth), and relevant guidance from ARPANSA, ICRP, and IAEA. Key radiological models used in the assessment include the RESRAD code (for dose modelling to public receptors) and the ERICA Tool (for assessment of potential impacts to non-human biota). Consideration is also given to the WA Work Health and Safety (Mines) Regulations 2022.

The scope of the Radiation Impact Assessment includes:

- Characterisation of the radioactive content of Osprey ore and associated residue and product streams.
- Identification and modelling of relevant exposure pathways, including airborne dust, groundwater, external gamma, ingestion of contaminated water (including rainwater), and external exposure from deposited radionuclides.
- Quantification of cumulative radiological impacts from operations and post-closure scenarios, including product transport.
- Evaluation of regulatory thresholds for radioactive materials, including trigger levels for classification under the EPBC Act and Radiation Safety Act.

Key findings of the assessment are as follows:

Ore and products:

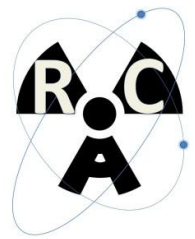
Ore and wet processing residue streams (sand tails and clay fines) remain below classification thresholds and are not regulated as radioactive. The produced Osprey HMC is likely to exceed the 1 Bq/g activity threshold for classification as radioactive material under WA WHS (Mines) Regulations.

Public doses:

All modelled public exposure pathways result in doses significantly below the 1 mSv/year public dose limit. The worst-case exposure scenario resulted in an estimated dose of ~0.026 mSv/year. Noting the land is designated for native vegetation and is unlikely to support residential use, a residential scenario was modelled as a conservative worst-case scenario.

Environmental impacts:

The ERICA Tool assessment shows that all relevant species groups, including user specific species, are exposed at levels below no-effect screening thresholds, and well below Derived Consideration Reference Levels (DCRLs), indicating negligible radiological risk to non-human biota.



Cumulative impacts:

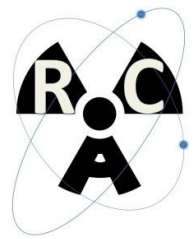
The assessment considered additive doses from overlapping exposure pathways, transport activities, and other operations in the region. Cumulative doses remain below applicable limits and can be managed under existing licence conditions.

Transport:

Estimated doses to members of the public from transport of HMC and other materials are negligible (<0.01 $\mu\text{Sv}/\text{year}$), even under conservative assumptions for roadside occupancy and traffic volume.

The Radiation Impact Assessment concludes that the proposed Osprey extension can proceed without causing significant radiological risk to human health or the environment. Compliance with the Radiation Safety Act 1975 (WA), WHS (Mines) Regulations 2022 (WA) and other applicable legislation will be achieved through implementation of existing radiation management and monitoring systems.

Monitoring will continue in accordance with the Radiation Management Plan, focusing on gamma dose rates, groundwater, airborne dust, and other key pathways at Cooljarloo. Ongoing compliance and performance reporting will ensure that radiation risks remain As Low As Reasonably Achievable (ALARA) throughout the life of the project.



1. INTRODUCTION

1.1 Purpose of this report

The purpose of this technical report is to:

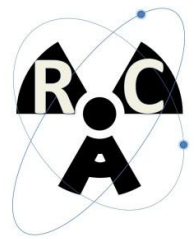
- Assess the potential for impacts to non-human biota and members of the public arising from the radiological impacts due to mining, processing, and handling of Osprey ore, products and processing residues (sand tails and clay fines). In addition, radiological impacts will be considered for storage, processing and disposal of materials onsite and for the transportation of HMC product offsite.
- Assess the potential for impacts to human health arising from the cumulative radiological impacts due to mining, processing, and handling of Osprey ore, products and processing residues (sand tails and clay fines), including the post-closure phase.

The assessment of potential radiological impacts to non-human biota has been undertaken using the Environmental Risks from Ionising Contaminants: Assessment and Management (ERICA) Tool. The RESidual RADioactivity (RESRAD) model has been used for assessment of the dose or risk associated project derived radioactive material to human receptors during operations; rehabilitation; and potential final land use scenarios.

This report consists of two scenarios (planned operations and post-closure), each of which include the following:

- An outline of the relevant radiological characteristics of the scenario,
- A description of the methods for the assessment,
- Assessments of the radiological impacts to representative and user-specific flora and fauna (referred to as non-human biota (NHB)), and,
- Assessment of doses to members of the public (from continued land use), comparing to the ICRP dose limit (1 mSv/year for members of the public), and,

Although the Osprey Project is a 12-month extension, the assessment also includes consideration of previous mining activities across the Cooljarloo site, which, despite being approved prior to the introduction of the EPBC Act, contribute to potential cumulative radiological impacts within the region.



2. PROJECT DESCRIPTION

2.1 Project overview

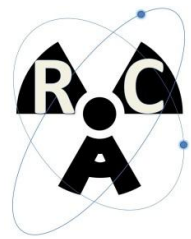
Tronox Management Pty Ltd (Tronox) proposes to undertake a short-term extension of mining operations at the Cooljarloo Mineral Sands Mine in Western Australia, known as the Osprey Project ('the project'). The existing Cooljarloo Mine is located approximately 170 km north of Perth on the Swan Coastal Plain and has been in continuous operation since 1989. The Osprey orebody lies directly adjacent to the existing mining area and represents a lateral extension into an undeveloped portion of the Cooljarloo deposit.

The Osprey Project encompasses approximately 250 hectares and will involve the relocation of the existing floating dredge and concentrator into the new orebody footprint. The proposed activities at Osprey include:

- Site Preparation: vegetation clearing, topsoil and overburden removal and stockpiling
- Dredge Mining: dredge-based ore extraction in a water filled pit with ore extraction under the water table
- HMC production: in-pit beneficiation of heavy mineral concentrate (HMC) in a floating wet concentrator plant (WCP) using gravity separation
- HMC Transfer: The HMC will be transferred via enclosed slurry pipelines to the existing stockpile on the neighbouring mine. No HMC will be stockpiled at Osprey. The HMC will be transported offsite from the neighbouring mine.
- Pit backfill and rehabilitation: progressive backfilling and rehabilitation of mined voids.

The project is expected to operate for a 12-month period and will be the subject of a referral under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) due to potential interactions with Matters of National Environmental Significance (MNES), including the presence of Banksia Woodlands and habitat for the Carnaby's Black Cockatoo (*Zanda latirostris*).

While the Osprey extension constitutes a relatively short-duration operational change, the existing immediately adjacent Cooljarloo site has not previously been subject to a comprehensive radiation impact assessment. The existing Cooljarloo Mine has been operating under an approved radiation management plan for multiple decades. As such, this assessment evaluates not only the incremental radiation impacts from the Osprey Project, but also considers the cumulative radiation exposure context from more than three decades of prior mineral sands mining at the site. The focus is on potential exposure to members of the public and non-human biota, with modelling based on current and historical monitoring data, and validated assumptions consistent with Australian and international guidelines.



2.2 Key project components

The Osprey Project area is confined to a 250-hectare extension zone located immediately adjacent to existing mining operations at the Cooljarloo Mineral Sands Mine. While the project footprint lies within the broader Cooljarloo Mine boundary, it constitutes a distinct referral area for the purposes of environmental assessment under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Osprey project area includes:

- A dredge path and in-pit floating concentrator, targeting the portion of the orebody to be mined over the 12-month operational period
- Areas designated for vegetation clearing, topsoil and overburden removal, and in-pit deposition of process residues (sand tails and clay fines)

No downstream processing plant, HMC drying infrastructure, or product stockpiles will be located within the Osprey project area. All heavy mineral concentrate (HMC) produced from the Osprey dredge path will be transferred via an enclosed slurry pipeline to off-site facilities already operating within the existing Cooljarloo Mine footprint.

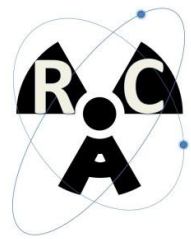
While the on-site project area is limited to site preparation, active dredging and rehabilitation activities, the existing Cooljarloo Mine infrastructure plays a critical role in the overall project and forms the basis of potential cumulative impacts. These include exposures related to long-term HMC handling, product transport, and legacy mining areas, which form part of the holistic assessment of radiation impacts associated with the Osprey Project.

2.3 Project development

2.3.1 Mining and mineral processing

Ore (present as ore-bearing sands) within the Osprey Project area will be mined using a floating dredge system, which allows for continuous excavation of saturated sands beneath the water table. Overburden and topsoil will be removed and stockpiled ahead of dredging and progressively returned to the mined void once ore extraction is complete. As with the broader Cooljarloo operation, mining will proceed in a progressive strip-mining fashion, with concurrent rehabilitation of completed areas to minimise the active disturbance footprint at any one time.

The ore is processed in situ using a floating wet concentrator plant (WCP), which separates the heavy mineral fraction from sand and clay through gravity separation techniques. The resultant heavy mineral concentrate (HMC) is then pumped via an enclosed slurry pipeline to the existing Cooljarloo Mine infrastructure located outside the Osprey Project boundary. No further mineral separation or drying occurs within the Osprey area. In an HMC slurry pipeline, the dominant radionuclides (U and Th-series in zircon/monazite grains) are transported as solids; under neutral, oxygenated process water at ambient temperature there is little mechanism for the in-pipe concentration of NORM (Naturally Occurring Radioactive Material) scale. Any settled material therefore reflects the activity of the HMC itself rather than a further concentration step. Although radium can co-precipitate into some scales in some industries, Radium (and associated Pb-210/Po-210) scale formation is primarily an oil/gas brine issue, and is not expected in neutral HMC slurries. Any build-up within the line would be physical accumulation of HMC with activity concentrations consistent with the feed.



Subsequent processing of the HMC—including separation into final mineral products such as ilmenite, leucoxene, zircon, and rutile—takes place off-site at Tronox’s Chandala Mineral Separation Plant, located approximately 120 kilometres south of Cooljarloo. Final products are then transported to domestic and international markets via road, rail, or port infrastructure.

2.3.2 Mineral processing waste

Mineral processing residues generated within the Osprey Project area will be limited to sand tails and clay fines, both of which are managed entirely in-pit. As mining is conducted via a floating dredge and in-pit wet concentrator plant (WCP), all processing occurs within the active dredge path, and no external residue storage facilities are required within the referral area.

The sand tails, representing the non-valuable quartz component of the ore, will be deposited directly back into the mined voids behind the dredge path. Once deposition is complete and the material is deemed geotechnically stable, it will be capped with overburden and topsoil in accordance with the site’s progressive rehabilitation plan.

Clay fines, which are separated during the gravity concentration process, will also be deposited in-pit. Their placement is managed to promote settling and long-term consolidation beneath the returned sand and overburden layers.

No oversize rejects, HMC waste, or non-saleable mineral by-products will be produced or stored within the Osprey Project area. All HMC is transferred by enclosed pipeline to off-site storage area pending transfer offsite for further downstream processing.

2.3.3 Rehabilitation and closure

Following ore extraction within the Osprey Project area, all process residues (sand tails and clay fines) will be deposited within the mined void to restore the landform. These materials will be allowed to settle and consolidate in situ. Once the backfill surface has stabilised above the natural water table, it will be progressively covered with overburden, subsoil, and topsoil, in that order, to re-establish a stable and geotechnically suitable final landform.

Progressive rehabilitation is a key aspect of the project’s closure strategy. Wherever practicable, overburden will be returned directly to the pit following dredging to avoid external stockpiling and to enable timely rehabilitation of mined areas. Subsoil and topsoil will be reapplied over backfilled zones to support revegetation, with the aim of returning the area to a condition consistent with surrounding native ecosystems.

2.3.4 Off-site infrastructure and activities

The Osprey Project will utilise existing off-site infrastructure already established for the broader Cooljarloo operations. No new off-site infrastructure will be constructed specifically for the Osprey project.

All heavy mineral concentrate (HMC) produced from the Osprey dredge path will be transported via an enclosed slurry pipeline to existing infrastructure located outside the Osprey referral area, including stockpiling at the Cooljarloo Mine site. From there, HMC will be transported via truck to the Chandala Mineral Separation Plant, located approximately 120 km to the south.



While no processing or product handling occurs within the Osprey Project boundary, the project's reliance on existing infrastructure means that transport, handling, and long-term storage associated with Osprey-derived materials will occur off-site and are included in the assessment of potential cumulative radiological impacts.

2.4 Radiological context

Low levels of uranium and thorium mineralisation are associated with the orebodies, which results in uranium and thorium, along with their associated daughter products being present in varying concentrations across process materials and end products. The concentrations of radionuclides in materials relevant to this assessment are shown in Table 2-1 (derived from measured concentrations in Cooljarloo materials).

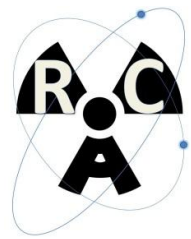
Table 2-1: Radionuclide concentrations of relevant materials.

Material	Uranium mass concentration (ppm)	Uranium ²³⁸ activity concentration (Bq/g)	Thorium mass Concentration (ppm)	Thorium ²³² activity concentration (Bq/g)
Topsoil/Overburden	0.7	0.009	5	0.020
Ore	1.1	0.014	14	0.057
HMC	66	0.825	699	2.85
Process residues (sand tails and clay fines)	0.16	0.002	1.26	0.005

When mining and processing is carried out with materials containing uranium and thorium, there is the potential for radiological impacts to the environment, or radiological impacts to workers and members of the public to occur. It is therefore important to measure and characterise the potential dose pathways for workers, members of the public and non-human species present in the environment, to determine whether there are any radiological impacts, and what dose pathways may require further control. This impact assessment focuses on the member of public and non-human biota doses (worker doses are assessed under the site radiation management plan).

The potential dose pathways are dependant on how materials will be handled. These radionuclides may enter the surrounding environment through several key exposure pathways. The most relevant are described below:

- **Airborne Dispersion (Dust Emissions)**
 - **Source:** Wind erosion of stockpiles, process residues (sand tails and clay fines), and disturbed soil surfaces, processing operations and vehicle movement.
 - **Radionuclides:** Typically bound to mineral particles, especially in fine dust fractions.
 - **Exposure Route:** Deposition onto soil, water bodies, vegetation and inhalation by humans or fauna.
 - **Pathway:** Direct inhalation, indirect ingestion via contaminated surfaces, or bioaccumulation in plants and animals.

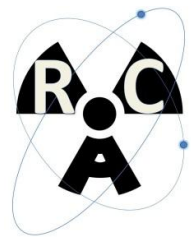


- **Waterborne Pathways (Surface and Groundwater)**
 - **Source:** Mobilisation of radionuclides from exposed process residues (sand tails and clay fines) or mineralised material via rainfall runoff or seepage.
 - **Radionuclides:** May dissolve or sorb to colloidal particles depending on pH, redox, and geochemistry.
 - **Exposure Route:** Uptake by aquatic organisms; potential migration into surface or groundwater used for irrigation or stock watering.
 - **Pathway:** Accumulation in aquatic biota; transfer to humans or livestock through consumption.

- **Soil Infiltration and Root Uptake**
 - **Source:** Dust deposition or runoff settling onto agricultural soils.
 - **Exposure Route:** Radionuclides may be absorbed by plant roots depending on chemical speciation and soil properties.
 - **Pathway:** Entry into food crops (e.g. cereals) or fodder, leading to potential ingestion by livestock or humans.

- **Bioaccumulation in Fauna and Livestock**
 - **Source:** Consumption of contaminated vegetation or drinking water; incidental soil ingestion.
 - **Exposure Route:** Transfer of radionuclides into body tissues of grazing animals (e.g. cows, sheep, kangaroos).
 - **Pathway:** Radionuclides may concentrate in organs such as bone or liver; potential entry into human food chain via meat or dairy products.

- **External Gamma Radiation**
 - **Source:** Gamma-emitting radionuclides in exposed soils, stockpiles, or external to products during transport.
 - **Exposure Route:** Direct external irradiation to workers, residents, or wildlife over contaminated ground. External irradiation of members of public on transport routes.
 - **Pathway:** Penetrating gamma radiation from decay chains contributes to dose even without material contact.



- **Inhalation of Radon and Progeny**

- **Source:** Radon²²² (from Ra²²⁶, U-series) and Radon²²⁰ (thoron, from Th-series) gas emanating ore, and HMC.
- **Exposure Route:** Inhalation of radon gas and its radioactive progeny (e.g. Po²¹⁸, Pb²¹⁴).
- **Pathway:** Internal irradiation of lung tissue; particularly significant for long-term exposure scenarios (e.g. residents or on-site workers).

2.5 Project area and study area

As noted in Section 2.2 above the project area is comprised of the proposed Osprey mine area (on-site area) and off-site areas.

For the purposes of this radiation impact assessment the study area is the proposed Osprey mine area. The transport route study areas are described in section 6.2.2.

3. EVALUATION FRAMEWORK

The following sections describe the legislation, policy, standards and guidelines relevant to this radiation impact assessment, and the assessment criteria adopted for the purposes of the assessment.

3.1 Legislation, polices, guidelines and standards

The legislation, policy, guidelines, and standards relevant to this Radiological Risk assessment are summarised in Table 3.1.

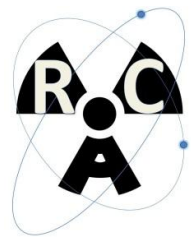
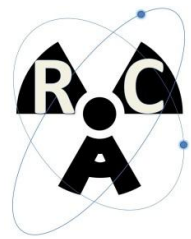
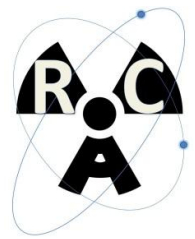


Table 3-1: Legislation, policy and guidelines summary

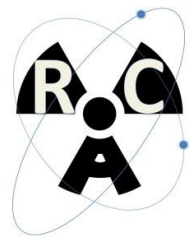
Document title	Summary	Relevance to the project
International Standards		
ICRP Publication 103 (2007) Recommendations of the ICRP	Establishes the international system of dose limitation: justification, optimisation (ALARA), and dose limits.	Forms the basis for radiation protection measures adopted for the Osprey Project. Dose limits for public exposure (1 mSv/year) are referenced.
ICRP Publication 91, 2003 A framework for assessing the impact of ionising radiation on non-human species	Recognises that environmental protection must be directly assessed, not assumed from human protection alone.	Non-human biota impacts are assessed separately in the Osprey Project following this approach.
ICRP Publication 137, 2017 Occupational Intakes of Radionuclides: Part 3.	Provides dose coefficients for naturally occurring radionuclides via inhalation and ingestion.	The dose coefficients are adopted in Australia by ARPANSA and are used in worker and public dose assessments.
IAEA Safety Standards Series GSR Part 3, 2014 Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards	Sets out international safety requirements for radiation protection, consistent with ICRP recommendations.	Confirms Australia's regulatory framework and the project's compliance with international standards.
IAEA Technical Reports Series # 472, 2010 Handbook of parameter values for the prediction of radionuclide transfer in terrestrial and freshwater environments	Provides international concentration ratios for transfer of radionuclides through ecosystems.	Used to assess potential ingestion doses for radionuclides bioaccumulated in plants and animals.



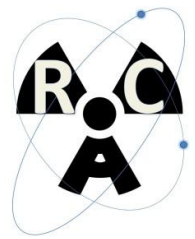
Commonwealth Legislation and Australian Standards		
<p>Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999</p> <p>and</p> <p>Environment Protection and Biodiversity Conservation Regulations (EPBC Act) 2000</p>	<p>Federal legislation identifying "nuclear actions" requiring assessment based on radioactive material concentrations.</p> <p>Formal determination under the EPBC Act confirming the Osprey Project is a "nuclear action" and requires assessment under Part 8 of the Act.</p>	<p>The nuclear action trigger for the EPBC Act refers to the radioactivity concentration in materials.</p> <p>The nuclear action referral triggers are:</p> <ul style="list-style-type: none"> Establishing, significantly modifying, decommissioning, or rehabilitating a facility where radioactive materials at or above a specified activity level are, were, or are proposed to be used or stored.
<p>Australian Radiation Protection and Nuclear Safety Act (ARPANS Act) 1998</p> <p>and</p> <p>Australian Radiation Protection and Nuclear Safety Regulations (ARPANS Regulations) 2018</p>	<p>Establishes ARPANSA and framework for national radiation protection. Defines dose limits and key standards.</p>	<p>Supports national consistency; referenced in compliance and assessment activities for the project.</p>
<p>ARPANSA 2005 Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing</p>	<p>The Mining Code, developed by the national Authority ARPANSA, outlines the expectations for radiation protection in mining and processing of radioactive ores. It is adopted in state regulations.</p>	<p>The Mining Code provides guidance on dose assessment of doses, specifically for mining operations.</p>
<p>ARPANSA 2010 Environmental Protection: Development of an Australian approach for assessing effects of ionising radiation on non-human species. Technical Report Series No. 154</p>	<p>Reviews international methods and endorses ERICA Tool for assessing radiological effects on non-human species.</p>	<p>The ERICA tool has been used to assess the radiological impacts of the project.</p>



<p>ARPANSA 2015 Guide for Radiation Protection of the Environment (2015), Radiation Protection Series G-1</p>	<p>Outlines approach for assessing impacts on non-human species, introducing environmental screening levels.</p>	<p>Used to set screening thresholds (e.g., 10 $\mu\text{Gy/h}$) for environmental receptors at Osprey. The document recommends an approach that is “as simple as possible but as complex as necessary” which assists in optimising the resources spent on the assessment and allows for a graded approach to protection. This involves initially screening using simplified methodology and deliberately conservative assumptions and parameter values, against a screening value of dose rate.</p>
<p>ARPANSA Code for Radiation Protection in Planned Exposure Situations (2020)</p>	<p>Aligns Australian exposure management with international standards.</p>	<p>Guides radiation protection strategies and operational planning.</p>



State specific		
Radiation Safety Act 1975 (WA)	Primary legislation regulating radiation safety and radioactive materials in WA.	Applies to all radiation-related activities on site.
Radiation Safety (General) Regulations 1983	Specifies licensing requirements, activity thresholds, and safety controls for radioactive substances.	Requires licensing for mineral processing and transport of radioactive ores or waste.
Work Health & Safety Act 2020 (WA) and WHS (Mines) Regulations 2022	Covers worker health and safety in the mining sector.	Mandates management systems in accordance with the Department of Local Government, Industry Regulation and Safety (DLGIRS) requirements.
Environmental Protection Act 1986 (WA)	Establishes environmental protection objectives and impact assessment requirements.	Ensures radiation is considered in cumulative environmental impact assessments.
Contaminated Sites Act 2003 (WA)	Provides mechanisms for the identification, reporting, and management of contaminated sites.	Supports site rehabilitation planning and potential legacy radiation assessment.

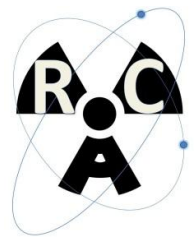


3.2 Assessment criteria

This section outlines the assessment criteria for the Radiation Impact Assessment, aligned with legislative requirements and the International Commission on Radiological Protection (ICRP) recommendations. These criteria are:

- **Public Dose Limit:** Ensure public radiation doses do not exceed the annual limit of 1 mSv, encompassing all exposure pathways, including:
 - Gamma irradiation,
 - Inhalation of radionuclides in dust,
 - Ingestion of radionuclides, and
 - Inhalation of radon decay products.
- **ALARA Principle:** Ensure doses are As Low As Reasonably Achievable (ALARA), considering economic, social, and environmental factors. ALARA is achieved by minimizing unnecessary exposures and ensuring predicted and measured doses remain well below the statutory limit.
- **Non-Human Biota:** For impacts on non-human biota, the assessment follows ARPANSA 2015 guidance, which establishes a screening level of 10 $\mu\text{Gy/h}$. Doses exceeding this level require further detailed evaluation.

These criteria ensure radiation management is in line with industry best practice, balancing safety, practicality, and environmental considerations while adhering to regulatory standards.



4. METHODOLOGY

4.1 Overview

A risk-based, as simple as possible but as complex as necessary approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects.

The approach used in the assessment has been guided by the regulatory framework (that is, applicable legislation and policy) as well as best practice within the radiation protection industry, particularly in the Australian context.

The radiation impact assessments followed these steps:

- Defined the study area and characterised baseline environment.
- Reviewed project details, including components, locations, predicted radionuclide deposition, and worst-case receptors (on-site and off-site).
- Conducted risk-based analysis to evaluate potential impacts, their likelihood, and planned mitigation measures to prioritise key issues.
- Assessed impact severity, extent, duration, and receptor sensitivity/significance.
- Compared outcomes against relevant legislation, policies, and standards.
- Evaluated cumulative impacts from the project combined with other existing or proposed projects affecting the same environmental receptors.
- Identified additional mitigation measures for significant impacts.
- Reported residual impacts (magnitude, duration, extent) after accounting for mitigation effectiveness.

Specific methods for each step are detailed in the following sections.

4.2 Definition of the study area

4.2.1 Mine site study area

To assess the radiological environment at the Osprey Project site and surrounding areas, the Radiation Impact Assessment has adopted a Study Area encompassing a 10 km radius around the Project. This area is depicted in Figure 4-1.

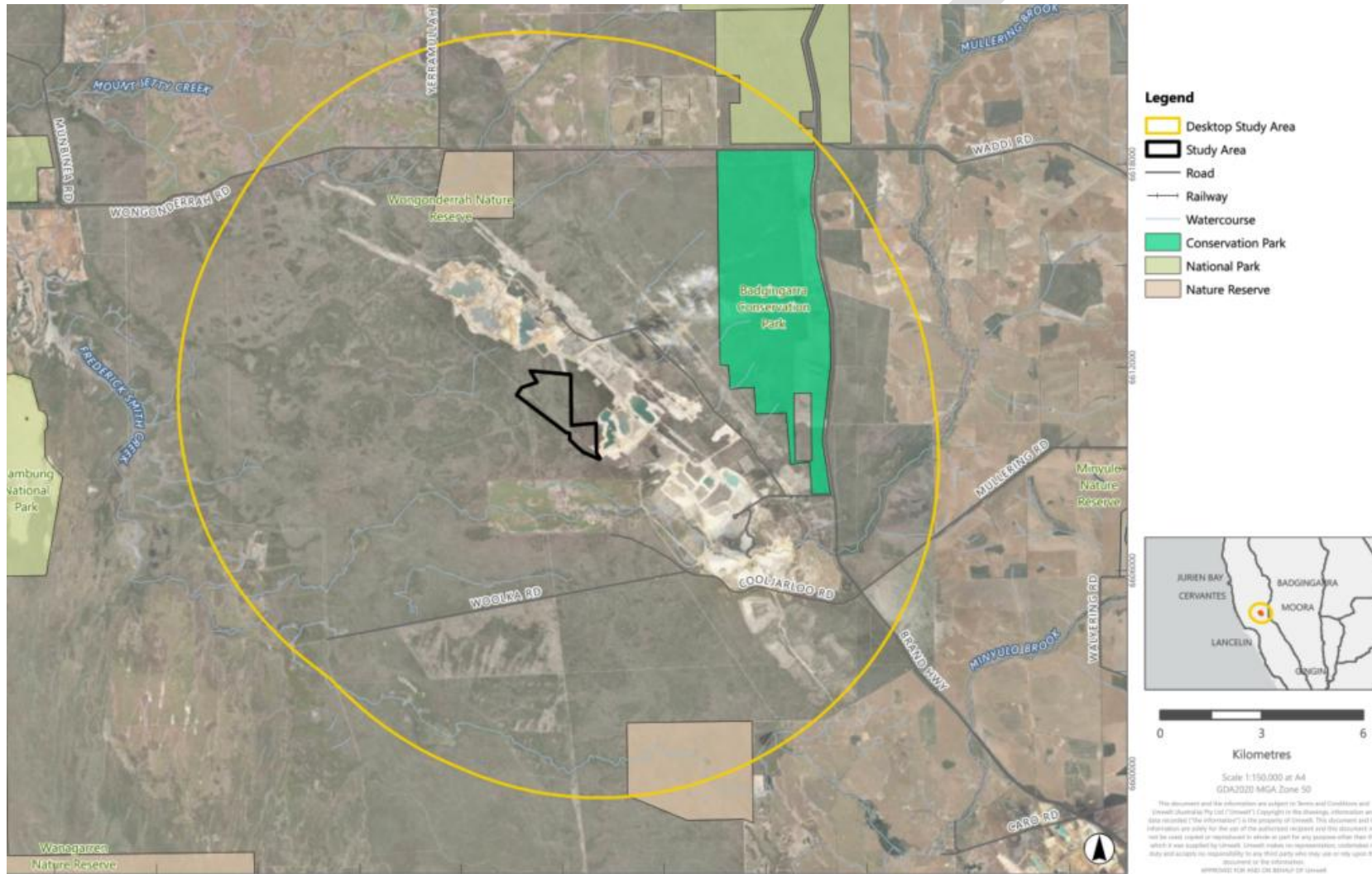
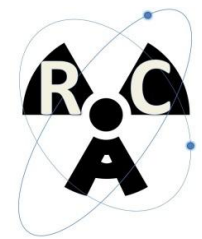
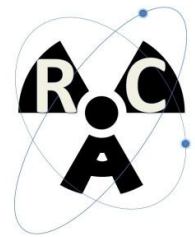


Figure 4-1: Radiation Impact Assessment Study Area



4.3 Existing environment

Existing conditions (baseline) have been established across the study area based on a review of monitoring data collected by Tronox, including:

- concentration of naturally occurring radioisotopes in soil
- external gamma radiation dose rate
- activity concentration of airborne long-lived radioisotopes

4.4 Avoidance and minimisation

Radiological impacts on the environment arise when project derived radionuclides are released. Key pathways include:

- Atmospheric emissions (and deposition)
- Accidental spills
- Migration into groundwater systems

4.4.1 Proposed Osprey Mine site

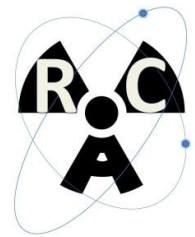
The following avoidance and mitigation measures have been incorporated into the project design:

- Ore mined under dredge conditions under the water table
- Ore mined and pumped in a slurry state
- Mineral processing utilises wet concentration and separation processes
- Export HMC to neighbouring site is sealed slurry pipeline
- No stockpiling HMC at Osprey Project

Administrative controls that will be implemented during the life of the project include:

- Detailed procedures for spill response and clean-up
- Incident reporting and investigation in accordance with Tronox's Environment Management System
- Environmental monitoring of radionuclide concentration in air, groundwater and soil

These controls detailed in the existing Radiation Management Plan for the site.



4.4.2 Transport routes

Transport is not directly required for the Osprey Project as the HMC will be transferred via a slurry pipeline to the adjacent Cooljarloo Mine for storage and transport. At the Cooljarloo Mine, the following avoidance and mitigation measures are actively undertaken for existing operations:

- Wash-down facilities for use by vehicles and equipment prior to leaving site
- Mineral products transported off-site in enclosed containers (roll tarp side tippers)

The following avoidance and mitigation measures will be incorporated into the project administrative controls:

- Trucks used to transport mineral products will be placarded as and if required.
- Contractors involved in transport, storage and handling will be appropriately licenced under the relevant State radiation legislation as and if required.

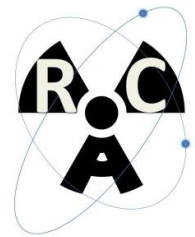
4.5 Impact assessment

Impacts are described as changes or effects to baseline environmental conditions, assets, or values as a result of activities driven by the project. The extent of any impact is measured against the baseline conditions assessment. Impacts may be referred to either prior to mitigation (potential impact) or following mitigation (residual impact). Impacts can be positive or negative, direct, or indirect.

4.6 Limitations, uncertainties and assumptions

The following limitations, uncertainties and assumptions apply to this assessment:

- Assumptions for calculations are detailed in Section 5 and Section 6.
- Radionuclide concentrations of process streams and material are based upon measured concentrations to date (for Cooljarloo).
- Dust deposition estimates are based on historical monitoring, inclusive of any controls being implemented currently.



5. EXISTING ENVIRONMENT

Naturally occurring radiation is universal, stemming from radionuclides like uranium and thorium in the Earth's crust. Uranium, a heavy metal, averages about three parts per million (ppm) in crustal rocks, while thorium averages 8-12 ppm. Materials are deemed "radioactive" when radionuclide concentrations exceed thresholds set based upon the protection of human health and the protection of non-human biota from adverse effects. In resource development, projects mining materials with elevated uranium or thorium levels require careful radiological management. Regulatory limits, based on potential biological and ecological impacts, guide radiation protection measures.

5.1 Local context

The Osprey Project area is located immediately adjacent to the Cooljarloo Mineral Sands Mine in the Mid West region of Western Australia, approximately 170 km north of Perth and 10 km east of Cataby. The project area lies within a broad corridor of existing mineral sands development and associated infrastructure, bounded by mixed-use farmland, native vegetation, and Crown Land.

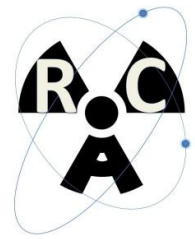
The local terrain is flat to gently undulating, underlain by Quaternary and Tertiary sediments of the Perth Basin. Vegetation within the Osprey Project area is remnant native vegetation with minimal disturbance. Surrounding land includes previously cleared land for mining, farmland and post mining rehabilitation.

There are no major natural surface watercourses within the Osprey footprint, as the area is located in a low-relief, semi-arid zone with ephemeral drainage. Surface water features are limited to shallow depressions and internal drainage systems that support seasonal wetting during rainfall events. Small wetlands or claypan systems may temporarily hold water following rain. Approximately 17 ha of the Project footprint is geomorphic Palusplain wetland (classified as flat land that is subject to seasonal waterlogging (DEC, 2010)) that is part of the listed Lancelin Defence Training Area Important Wetland (DCCEEW, 2018).

The regional water table beneath the Osprey Project area is typically shallow, ranging from 2 to 10 m below ground level, and is intersected during dredge mining operations. Groundwater in the region is generally brackish to saline, with total dissolved solids (TDS) commonly exceeding 5,000 mg/L. Local groundwater is rarely relied upon for potable or irrigation use, although the mine does abstract groundwater for mine site potable use. Other mines in the area with a groundwater allocation in the superficial aquifer include Iluka's Cataby mineral sands mine and Image Resources Atlas mine. There are no other groundwater users registered with 5 km of the proposed Osprey project.

The surrounding land is primarily crown land with remnant vegetation and low intensity agriculture. The area is sparsely populated, with the nearest sensitive receptor (residence) located several kilometres from the Osprey boundary.

The broader Cooljarloo Mine has an established history of environmental monitoring and impact management, which will be extended to include the Osprey extension footprint. The low population density, limited agricultural reliance on groundwater, and lack of nearby sensitive ecosystems support the finding that the project is situated in a relatively low-risk environmental setting from a radiological impact perspective.



5.2 Adopted baseline radiation values

Tronox has been operating the adjacent Cooljarloo Mine since 1989 and has in this time collected extensive monitoring data that can be applied to the Osprey Project area due to geographic proximity. This data is suitable to determine approximate pre-mining baseline radiological conditions applicable to proposed mining activities at Osprey.

5.2.1 Gamma dose rate at ground surface

Gamma surveys have been conducted historically (1993-2025) over the existing Cooljarloo Mine. The average dose rate at the soil surface across all locations (including boundary locations) is 0.1 $\mu\text{Sv/h}$. These dose rates are typical background environmental levels, with the average in Australia being 0.09 $\mu\text{Sv/h}$ (UNSCEAR, 2000).

5.2.2 Concentration of radionuclides in soil

Soil samples have been collected at the existing Cooljarloo Mine to give an activity concentration for overburden material. As the overburden material is considered consistent with that expected at Osprey, existing data is suitable for this assessment.

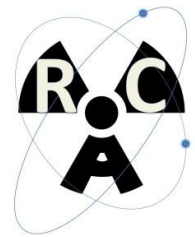
The average concentrations of uranium and thorium in overburden were around 0.7 ppm and 5 ppm respectively (Tronox RMP, 2023). These concentrations are low, but still typical of normal soils. For reference, the worldwide average uranium concentration is approximately 3ppm, and the worldwide average thorium concentration is approximately 9 ppm (UNSCEAR, 2000).

5.2.3 Summary of adopted baseline values

The baseline radiation values adopted for the purposes of the radiation impact assessment are summarised in Table 5-1 below.

Table 5-1: Adopted baseline radiation values

Parameter	Adopted value	Comments
U (ppm) in soil	0.7	Collected in 2021 and 2022 (15 locations)
U ²³⁸ Activity concentration in soil (Bq/g)	0.008	Derived from U (ppm)
Th (ppm) in soil	5	Collected in 2021 and 2022 (15 locations)
Th ²³² Activity concentration in soil (Bq/g)	0.033	Derived from Th (ppm)
Dose rate (nSv/h) at ground level	100	Average of measurements conducted since 1993



5.4 Other relevant technical considerations

5.4.1 Dust deposition

Dust deposition at the existing Cooljarloo Mine has been collected over a number of years, with the highest dust mass deposition occurring closer to operations. Tronox's Operating Licence issued by the Department of Water and Environmental Regulation (WA) for the Cooljarloo Mine requires regular depositional dust monitoring along the project boundary. An internal performance target for inorganic dust deposition has been set at $<10 \text{ g/m}^2/\text{month}$ at the lease boundary. No exceedances of the internal dust concentration were recorded in 2024, whilst 3 exceedances were reported in 2023. Despite average annual dust deposition rates being well below the performance target for all locations, that performance target has been used as a representative 'worst case' location. It is conservatively assumed that dust deposition has occurred at $10 \text{ g/m}^2/\text{month}$ for 30 years and will continue for the Osprey project.

The dust deposition modelled at this location is attributable to operational activities (dust generated by mineral processing, mining and stockpiling activities, including mining, hauling and stockpiling of soil and overburden). Dust emissions from process residues (sand tails and clay fines) were considered to not be significant due to wet processing (and the activity concentration of sand tails is lower than the activity concentration of ore).

6. IMPACT ASSESSMENT

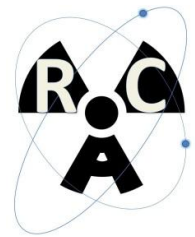
6.1 Overview of impact assessment approach

The radiation impact assessment was conducted using two internationally recognised models: RESRAD and ERICA. ERICA was used to evaluate potential radiological impacts to non-human biota by modelling dose rates to representative flora and fauna. The ERICA assessment incorporated predicted environmental radionuclide concentrations at closure and applied conservative assumptions, such as no radioactive decay over the operational period. RESRAD was applied to assess the potential radiation doses to members of the public from residual contamination across different exposure pathways, including inhalation, ingestion, and external exposure. The assessment considered long-term post-closure scenarios based on conservative assumptions about site use.

6.2 Assessment of impact to non-human biota using ERICA

The protection of the natural environment from emissions from nearby human activities has historically been based on the protection of humans. This approach was outlined by the International Commission on Radiation Protection (ICRP), which stated that "if man is protected then it can be assumed that the environment is protected" (ICRP, 1991). More recently, however, it has been generally expected that there is a need to demonstrate, rather than assume, that non-human biota living in natural habitats are protected against ionising radiation risks from radionuclides released to the environment by human activities (ARPANSA, 2014).

More recent publications (ICRP, 2014 and ARPANSA, 2015) have addressed this, and recommended that assessments be made on the impact of radiation on non-human biota. It is important to note that protection of non-human biota is demonstrated at the species level, rather than the individual level, as is the case for humans.



ARPANSA, 2015, suggests considering an as-simple-as-possible but as-complex-as-necessary approach to demonstrating protection, which assists in optimising the resources spent on the assessment and allows for a graded approach to protection. To facilitate this, a tiered approach may be used, which involves a first screening using simplified methodology and deliberately conservative (although not necessarily unrealistic) assumptions and parameter values, against a screening value of dose rate.

The ERICA tool

The ERICA Tool was developed under the European Commission to provide a method of assessing the impact of radiological contaminants to the natural environment.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has noted that the ERICA Tool is applicable for use in Australia (ARPANSA, 2010). The software uses changes in radionuclide concentrations and concentration ratios in species, derived from monitoring and studies, to provide an estimated dose and measure of radiological impact to a number of reference animals and plants (RAPs).

The database of the ERICA Tool has been built around a number of RAPs. Each RAP has a specified geometry, and default concentration ratio (CR) values. The geometry of an organism is represented as an ellipsoid – and by varying its axes – it can be used as a reasonable approximation for much of the existing wildlife on Earth (see Figure 6-1). Radiation damage arises due to ionisation along the path radiation takes as it passes through tissues, hence the dimensions of the organism have relevance to the degree of radiation damage that can occur. User specific organisms can be defined in ERICA, and the size and weight altered from that of RAPs.

Some simplifications introduced when using RAPs include:

- An assumption of homogenous radionuclide distribution in the tissues of the organism (for internal dosimetry),
- Generic biological data in terms of habitat, occupancy, life cycle, and reproduction among other factors.

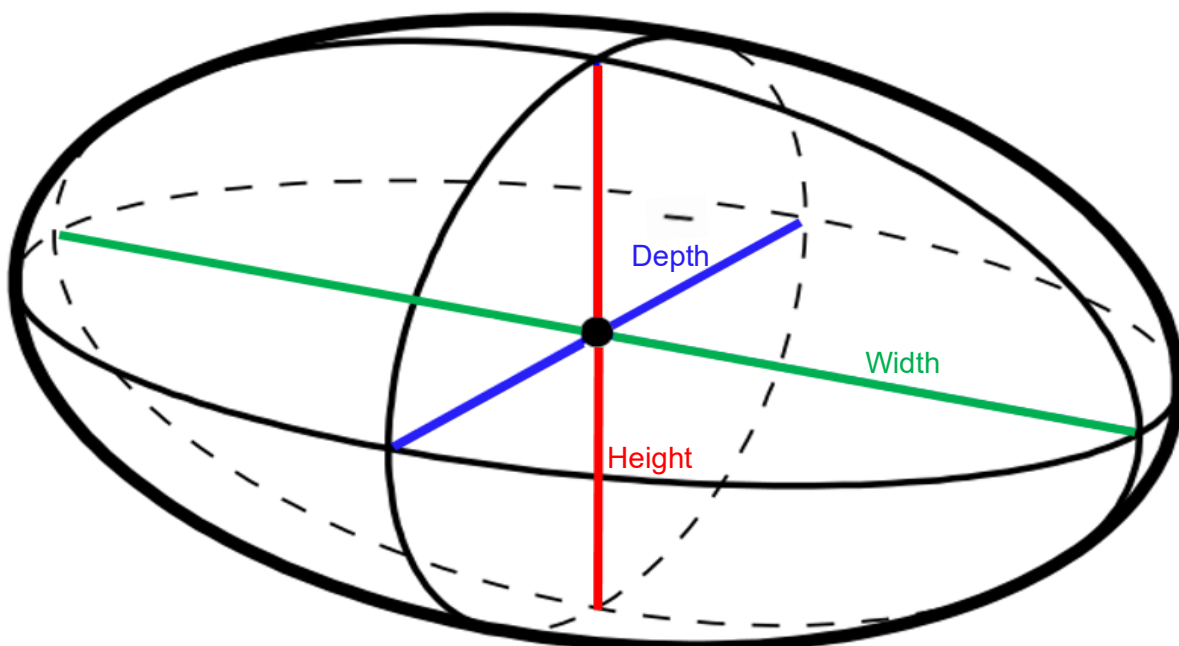
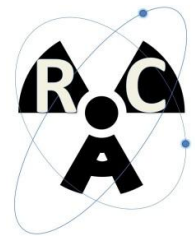


Figure 6-1: An example of an ellipsoid, which can be used to approximate the geometry of biota by varying the axes.



ERICA is a tiered assessment, and the level of assessment depends upon the level of impact, the higher the potential impact, the higher the level of scrutiny (ARPANSA, 2015). The tiered approach aims to ensure that the level of assessment is commensurate with the level of risk. The tiers are:

- Tier 1, the first assessment level, requiring the least amount of input data. Tier 1 assessments are used to determine a risk quotient for the site, based on generic data. Where the potential impacts are higher and more data is available, a Tier 2 assessment can be conducted.
- Tier 2, which allows the user to examine and edit most of the parameters used in the calculation including concentration ratios, distribution coefficients, percentage dry weight soil or sediment, dose conversion coefficients, radiation weighting factors and occupancy factors, and results in a dose rate, rather than a risk quotient. Tier 2 assessments are primarily intended to involve a more intensive literature search to modify the assumptions of the benchmark criteria used in Tier 1 (e.g. to use site specific data or more appropriate data identified in literature).
- Tier 3, which are performed when the likely impacts need to be further defined (e.g. if doses are above screening values, or Derived Consideration Reference Levels (DCRLs)). Tier 3 offers the same flexibility as Tier 2 but allows the option to run the assessment probabilistically if the underlying parameter probability distribution functions are defined.

Each assessment tier produces a dose rate which is comparable to a 'screening dose rate'. The default ERICA screening dose rate is 10 $\mu\text{Gy/h}$ (ARPANSA, 2015), which is the level below which no effects would be expected (to 95% or 99% of species, based upon selection) even to the most sensitive species (predicted no-effect dose rate).

The two important inputs for an ERICA assessment are:

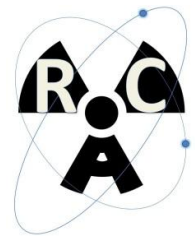
- Operationally derived changes in media concentration (the additional radionuclide concentration in soils or water attributable to the operation), in units of Bq/kg or Bq/L.
- The radionuclide concentration ratios, which is the ratio of radionuclide concentrations in flora and fauna to concentrations in the media.

These inputs allow external and internal doses to be estimated for reference (or user defined) animals and plants. User defined species with specific CR value data (where available) and user specified geometry allow the user to estimate doses to specific species more accurately.

The latest version of the ERICA software was released in June 2025 (version 2.0.230) and was used in the assessment. A Tier 2 ERICA assessment was conducted because additional concentration ratio data is available for various Australian species.

6.3 Assessment of impact to members of the public using RESRAD

RESRAD is a family of software tools used to model and estimate radiation doses and risks to an individual from residual radioactive materials. The software was developed by the Environmental Science Division of Argonne National Laboratory under the joint sponsorship of the US Department of Energy and the US Nuclear Regulatory Commission. RESRAD is used extensively worldwide to evaluate radiologically contaminated sites, including sites in Australia.



The RESRAD code is an internationally accepted method of assessing potential radiation exposure and risk because of its adaptability to specific exposure scenarios. RESRAD has been benchmarked against other codes in the environmental assessment and site clean-up arena, and its models have been assessed for validity by the International Atomic Energy Agency (IAEA, 2004; Cheng & Yu, 1993).

The RESRAD model estimates an individual's direct exposure to external radiation from contaminated soil and internal dose from the inhalation of airborne radionuclides originating from contaminated soil including radon emissions. The model can also be used to calculate internal doses from the ingestion of contaminated vegetables and leafy greens; meat; fish; milk; drinking water; and soil. The RESRAD code has become popular because of its adaptability to specific exposure situations.

RESRAD Onsite evaluates the cancer risk to an individual present (e.g. residing on, visiting, farming, working, etc.) within an area that is contaminated with radionuclides (Yu et al, 2001). The potential exposure pathways modelled within RESRAD Onsite are shown in Figure 6-2.

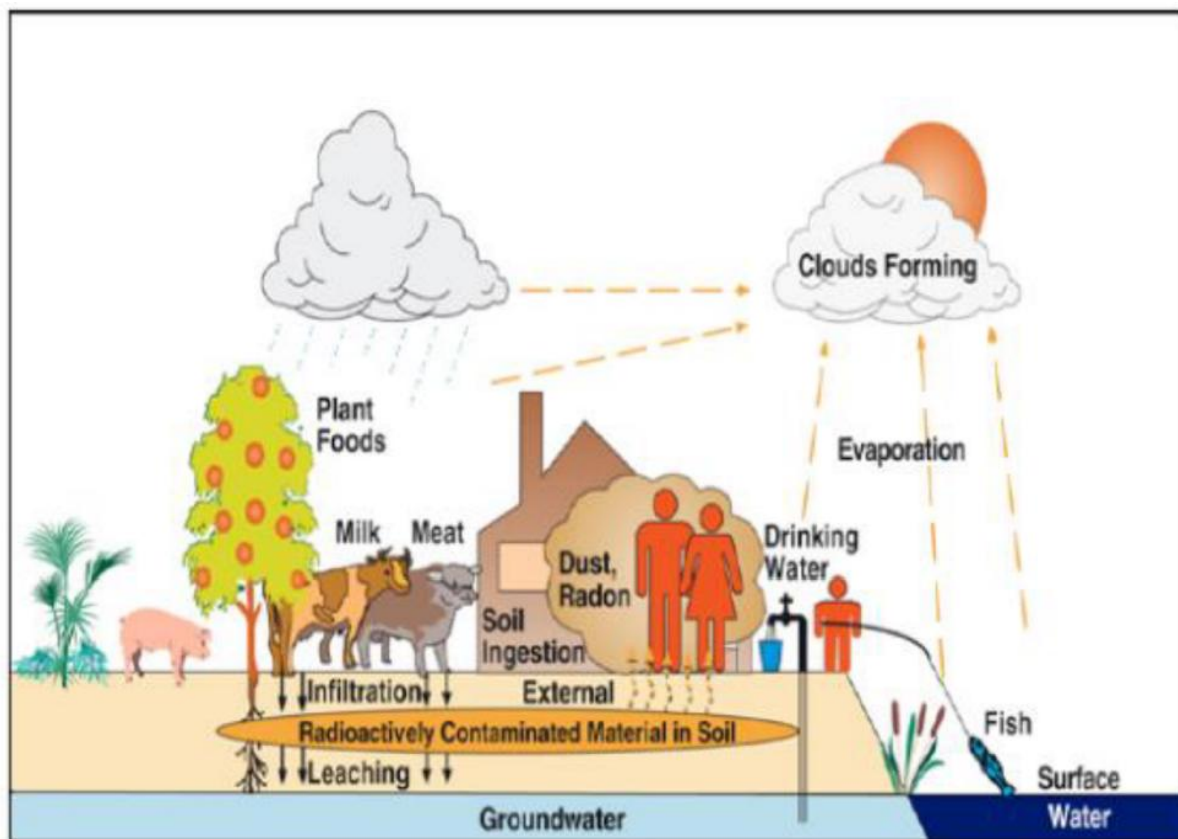


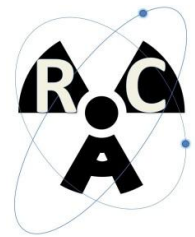
Figure 6-2: RESRAD Onsite potential exposure pathways

6.4 Transport impacts

Although there is no direct transport of HMC materials from the Osprey project, the HMC from Osprey will be stockpiled and transported from the neighbouring Cooljarloo Mine and therefore indirect transport is acknowledged.

There is a potential for radiological doses to members of the public arising from the transportation of products originating from the Osprey mine area. There are a number of scenarios that have been considered:

- A member of the public following a truck transporting mineral product (e.g. HMC).
- A static receptor (residence) near a transport route.



These scenarios are modelled conservatively using Wise Uranium External dose calculator (version 13/02/2024), to ensure compliance with the 1 mSv/year public dose limit set by the International Commission on Radiological Protection (ICRP).

6.4.1 Scenario 1: Member of the Public Following a Transport Truck

For this scenario it is assumed a member of the public will follow a truck transporting HMC in a sealed container (rolled tarp, side tipper) at a separation distance of 5 meters for 2 hours inside a typical light vehicle. Only the rear container is modelled (first containers are shielded).

Product Characteristics:

- an average of 75.23 t of HMC per truck
- U²³⁸ concentration: 66 ppm
- Th²³² concentration: 699 ppm

Dose Rate Calculations:

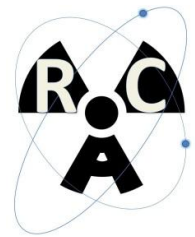
- Dose rate at 5 m from container (WISEuranium calculator): 0.034 µSv/h
- Exposure Time: 2 hours
- Total Dose: 0.068µSv = 0.000068 mSv

6.4.2 Scenario 2: Static Receptor Near Transport Route

This scenario models a residence located 10 meters from the edge of the transport route, with 78 trucks carrying sealed containers passing weekly. Each truck passes in approximately 2 minutes.

Dose Rate Calculations:

- Dose rate at 10 m: 0.05 µSv/h
- Per truck pass (2 minutes):
Dose = $0.05 \times (2 / 60) = 0.00166 \mu\text{Sv}$
- Annual frequency: 78 passes/week \times 52 weeks = 4,056
- Annual Dose: $0.00166 \times 4056 = 6.733 \mu\text{Sv} = 0.0067 \text{ mSv}$



6.4.4 Transport doses summary

All calculated doses are well below the ICRP public dose limit of 1 mSv/year. These results confirm that transport-related radiological impacts to the public from the Osprey Project are below member of public dose limits. The dose estimates are conservative and actual doses are expected to be lower due to shielding and transient exposures.

6.5 Modelled impact to non-human biota (ERICA)

6.5.1 Operations and closure phase

A review of dust deposition results from routine air quality monitoring undertaken at the existing Cooljarloo Mine determined that the additional average project-generated dust at the most affected receptor located closest to the operations was 7.4 g/m²/month (DG13). As a conservative worst-case approach the internal constraint of 10 g/m²/month was assumed (representing a conservatively worst-case reference location with 35% higher dust deposition compared to the most affected monitoring site on average). Over a 37 year period that would amount to 4,440 g of deposition per m².

Worst case radionuclide concentrations within the dust can be estimated based on using the maximum activity concentration measured in dust during HiVol monitoring. Assuming approximate secular equilibrium, the activity concentration of dusts collected from HiVol monitoring (East) is 0.0682 Bq/g Th²³² and 0.0117 Bq/g U²³⁸. Assuming this is the activity concentration of dusts, and knowing the deposition rate, the additional activity in the soil due to project derived radionuclides can then be calculated.

Assuming that all of the deposited material (i.e. that no material is redeposited elsewhere) mixes with the top 10 mm of soil over time (consistent with dust deposition data in Australian soil (Kaste, Heimsath and Bostick, 2007)), and assuming a soil density of 1500 kg/m³, the total activity in the soil can be determined. Based on the assumed concentrations, once mixing is considered, the additional contribution to soil activity concentrations above baseline as a result of project-related dust deposition is 20.19 Bq/kg Th²³² and 3.46 Bq/kg U²³⁸ respectively.

Assuming deposited daughter products are in approximate secular equilibrium, the soil concentrations (additional to baseline concentrations) applicable to ERICA are displayed in Table 6-1.

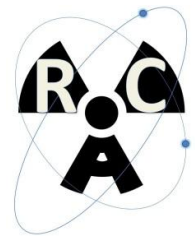


Table 6-1: Increased radionuclide concentrations in soil (worst-case scenario) after 37 years.

Radionuclide	Increased activity concentration in soil (baseline subtracted) (Bq/kg)
U²³⁸ Decay Chain	
U ²³⁸	3.46
Th ²³⁴	3.46
U ²³⁴	3.46
Th ²³⁰	3.46
Ra ²²⁶	3.46
Pb ²¹⁰	3.46
Po ²¹⁰	3.46
U²³⁵ Decay Chain	
U ²³⁵	0.16
Pa ²³¹	0.16
Ac ²²⁷	0.16
Th ²²⁷	0.16
Ra ²²³	0.16
Th²³² Decay Chain	
Th ²³²	20.19
Ra ²²⁸	20.19
Th ²²⁸	20.19

Estimated activity concentrations of radionuclides due to dust deposition in the soil, while showing a small increase in absolute terms, remains comparable to average concentrations of uranium and thorium in soils, with the worldwide average uranium concentration being approximately 3 ppm, and the worldwide average thorium concentration being approximately 9 ppm (UNSCEAR, 2000).

Using the increased concentration in soils as inputs to ERICA, the output doses to RAPs can be determined (using generic CR values), and are shown in Table 6-2, with doses calculated to the 99th percentile. All terrestrial RAPs available in ERICA were selected for assessment. It should be noted that radioactive daughter nuclides are included in the dose conversion coefficients of their parents if their half-lives are shorter than 10 days. The U²³⁵ decay chain is estimated based on the natural activity ratio of U²³⁸:U²³⁵, where U²³⁸ (Bq):U²³⁵ x 0.046 (Bq).

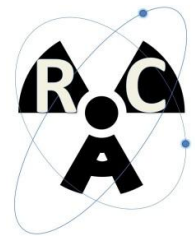


Table 6-2: Doses to terrestrial reference animals and plants at worst case receptor

Organism	Total dose rate per organism (μGy/h)	No effect dose threshold (μGy/h)
Amphibian (reference)	0.333	10
Annelid (reference)	0.418	10
Arthropod – detritivorous (reference)	0.448	10
Bird (reference)	0.069	10
Flying insects (reference)	0.110	10
Grasses & Herbs (reference)	1.05	10
Lichen & Bryophytes (reference)	3.22	10
Mammal – large (reference)	0.154	10
Mammal – small-burrowing (reference)	0.173	10
Mollusc – gastropod (reference)	0.113	10
Reptile (reference)	0.334	10
Shrub (reference)	0.996	10
Tree (reference)	0.058	10

Doses from placement of wet process residues (sand tails and clay fines) have not been estimated, as the doses to non-human biota will be significantly reduced by these materials being covered during pit backfilling. External dose rates from covered process residues are negligible (as demonstrated by RESRAD modelling), and no other dose pathway to non-human biota is considered relevant. It should also be noted that process residues (sand tails and clay fines) are less radioactive than the original ore.

Some additional data was used to determine doses to some user defined plants and animals, based on estimated size, mass and occupancy data outlined in Table 6-3. Where possible Australian data was utilised (Table 6-4), and has been used to determine doses to Australian plants and animals. ERICA default values have been used where additional data is unavailable.

User defined animals and plants were selected based on the availability of Australian data, and species of interest to the Osprey Project.

The species of particular interest to the project is the Carnaby Black Cockatoo (White-tailed Black Cockatoo) *Zanda latirostris* (EPBC Status: Endangered).

Table 6-3: User specific geometry, mass and occupancy values

Species	Organism mass (kg)	Height (m)	Width (m)	Length (m)	Occupancy Factor
Red Kangaroo (<i>Macropus rufus</i>)	45.0	1.5	0.75	0.75	100% on soil
Emu (<i>Dromaius novaehollandiae</i>)	34.0	1.75	0.4	1.5	100% on soil
Carnaby Black Cockatoo (<i>Zanda latirostris</i>)	0.65	0.3	0.2	0.6	80% in air, 20% on soil

*Default ERICA values used for pine tree (scaled for height)

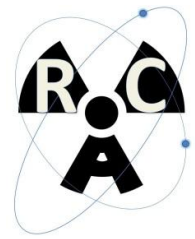


Table 6-4: User specific CR values derived from Australian data

Species	Elemental Concentration Ratio (Bq/kg fw whole organism / Bq/kg dw soil)						Source
	U	Th	Ra	Pb	Po	Pa	
Red Kangaroo <i>Macropus rufus</i>	0.0076	0.00111*	0.289	0.0222	0.598	0.0273*	ARPANSA, 2014
Emu <i>Dromaius novaehollandiae</i>	0.00146*	0.000469*	0.0347*	0.0592*	0.00997*	0.0283*	Default ERICA values for reference "Bird"
Carnaby Black Cockatoo <i>Zanda latirostris</i>	0.00146*	0.000469*	0.0347*	0.0592*	0.00997*	0.0283*	Default ERICA values for reference "Bird"

*Default ERICA values for the most appropriate RAP were used where Australian data was unavailable.

Using user-specific data for these species in ERICA, doses to RAPs have been calculated to the 99th percentile, shown in Table 6-5 (using the radionuclide concentrations in soil, from Table 2-1).

Table 6-5: Dose rate per terrestrial organism at worst case reference location after 37 years of operations

Organism	Total dose rate per organism ($\mu\text{Gy/h}$)	No effect dose threshold ($\mu\text{Gy/h}$)
Red Kangaroo <i>Macropus rufus</i>	0.489	10
Emu <i>Dromaius novaehollandiae</i>	0.581	10
Carnaby Black Cockatoo <i>Zanda latirostris</i>	0.069	10

All doses to RAPs and user-defined species in ERICA are below the screening threshold of 10 $\mu\text{Gy/h}$. The screening threshold is the threshold at which even the most sensitive NHB are unlikely to suffer any population effects as a result of chronic exposure to that dose. All doses to all species are below the screening threshold (see graph in Figure 6-3), and the appropriate DCRLs for each species. It can therefore be concluded that there are no impacts due to operationally derived radiation doses to NHB due to the proposed operations, including cumulative doses from historical mining activities. Several conservative assumptions have been used, in line with the "as-simple-as possible, but as-complex-as-necessary" approach suggested by ARPANSA G1 (2015), so actual doses are likely to be lower.

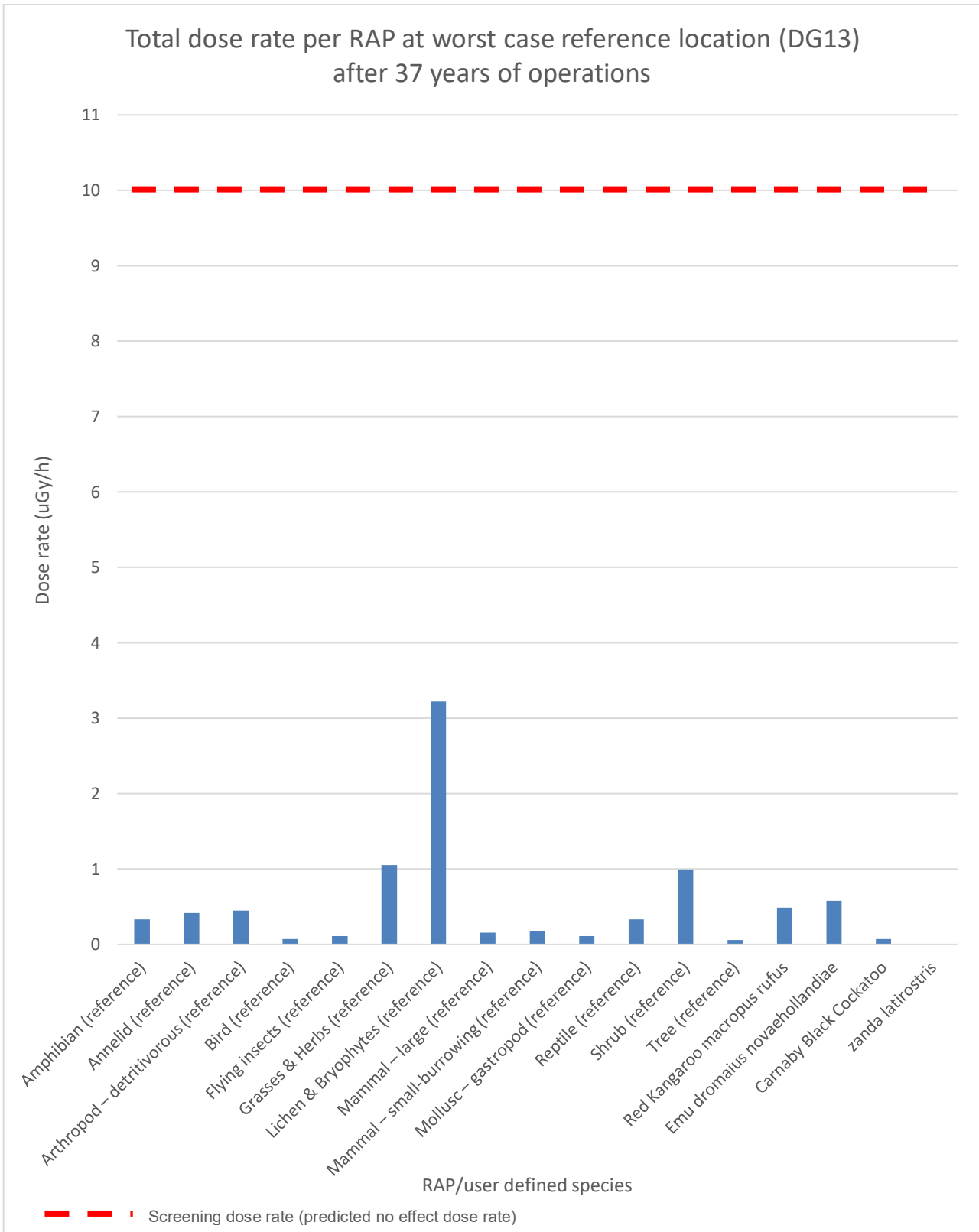
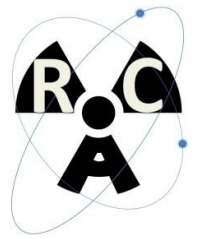
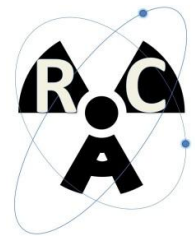


Figure 6-3: Total dose rate per RAP at worst case reference location after 37 years of operations



6.5.2 Post-closure phase

Post-closure radiation doses associated with the Osprey extension project are expected to progressively reduce over time as a result of natural radioactive decay and ongoing environmental stabilisation. The maximum predicted dose rates to non-human biota, assessed using the ERICA tool, relating specifically to the project, occur at the end of the project, at which point 37 years of operation (including the Osprey extension and Cooljarloo activities) have been modelled conservatively without accounting for radioactive decay or resuspension and dispersion during that period. In reality, radionuclides with shorter half-lives will decay significantly during the operational life of the project, and material will disperse over time - meaning that post-closure concentrations and associated dose rates will decline steadily over time, resulting in lower long-term radiological risks.

6.6 Modelled impact to members of the public (RESRAD)

RESRAD onsite (version 7.2) has been used to determine worst case exposure scenarios to individuals accessing the land directly over the next 1000 years or living near the study area.

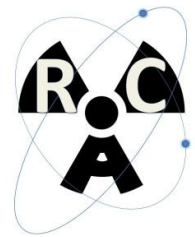
6.6.1 RESRAD modelled scenarios

A number of exposure scenarios have been calculated for the Osprey study area for members of the public, specifically:

1. Operations/closure phase: potential public doses at closest project boundaries (based on 37 years of dust deposition from not only the Osprey Project but also the neighbouring Cooljarloo Mine)
2. Post-closure: residential farmer living on land with increased radioactivity due to previous site operations.

The project mine closure strategy is return the Osprey Project area to native vegetation, consistent with the pre-mining land use. However, for the purposes of modelling a worst-case scenario for demonstration purposes, the model assumes the post-mining land use is residential farming. Short term intrusion on to the site is considered a possible scenario, however will only represent a fraction of the doses considered in each phase above (e.g. significantly shorter exposure periods). All short-term intrusion exposures are expected to be significantly below member of public dose thresholds (1 mSv/year).

Occupancy refers to the percentage of time a person spends in the location of interest. Occupancies for the different exposure scenarios vary, with the highest occupancy and greatest consumption of produce from the land at the highest potential risk (residential farmer). An occupancy of 95% is assigned to farmland with residence (ENhealth guidelines, 2021).



6.6.2 RESRAD input data

For most input parameters, site specific data was sought. Where no site data is available, RESRAD default values have been adopted. Table 3-1 outlines the soil media concentrations used in the assessment. Process residues (sand tails and clay fines) have not been modelled, given they are placed in pit in place of ore that had prior to being mined had higher radionuclide concentrations than the final process residue material. The overarching considerations within RESRAD are given below:

- A basic radiation dose limit of 1 mSv/year for members of the public
- Contamination zone of 0.1 m for short term
- Contamination zone was mixed to 5 m thick for farmers (due to mixing via rehabilitation activities, allowing deep enough to enter house under foundations)
- Average wind speed of up to 5.36 m/s (based on 19.3 km/h average monthly speed) (Gingin Aero) (BOM, 2025)
- Average rainfall of 624 mm/y (Gingin Aero) (BOM, 2025)
- Zone size 2,500,000 m² (study area 250 ha)

Soil activity concentrations for each exposure scenarios were the same as concentrations calculated in order to perform ERICA assessments, outlined in Table 6-6. For the residential farmer, it was assumed that radionuclide mixing due to rehabilitation activities may extend to 5m (allowing for potential radon emanation to potential dwellings). Although mixing to 5m requires a 500x dilution of radionuclides in soil, in order to be conservative a 10x dilution has been modelled (to account for scenarios such as equipment that has been used to handle HMC is used to undertake rehabilitation activities without undergoing cleaning, or process residue backfill material is disturbed and mixed). The U²³⁵ decay chain is estimated based on the natural activity ratio of U²³⁸:U²³⁵, where U²³⁸ (Bq):U²³⁵ x 0.046 (Bq).

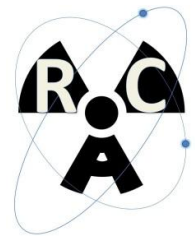
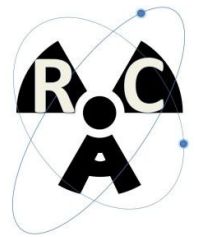


Table 6-6: Estimated increased radionuclide concentrations in soil after 37 years of operations (worst case)

Radionuclide	Increased activity concentration in soil (baseline subtracted) (Bq/kg)	Increased activity concentration in soil for a farmer, mixed to 5m depth (baseline subtracted) (Bq/kg)
U²³⁸ Decay Chain		
U ²³⁸	3.46	0.346
Th ²³⁴	3.46	0.346
U ²³⁴	3.46	0.346
Th ²³⁰	3.46	0.346
Ra ²²⁶	3.46	0.346
Pb ²¹⁰	3.46	0.346
Po ²¹⁰	3.46	0.346
U²³⁵ Decay Chain		
U ²³⁵	0.16	0.016
Pa ²³¹	0.16	0.016
Ac ²²⁷	0.16	0.016
Th ²²⁷	0.16	0.016
Ra ²²³	0.16	0.016
Th²³² Decay Chain		
Th ²³²	20.19	2.019
Ra ²²⁸	20.19	2.019
Th ²²⁸	20.19	2.019



6.6.3 Pathway Selection and Occupancy

All potential exposure pathways considered in RESRAD are shown in Figure 6-4. Exposure pathways and occupancies have been selected for each occupancy scenario and are presented in Table 6-7.

Two scenarios were selected to demonstrate a worst case scenario situation for the model:

- members of the public living near the site,
- farmers residing on the land post-closure.

These are both unlikely and not proposed in the Mine Closure Plan, however modelled for demonstration purposes. Noting that worker doses are already covered in the site Radiation Management Plan.

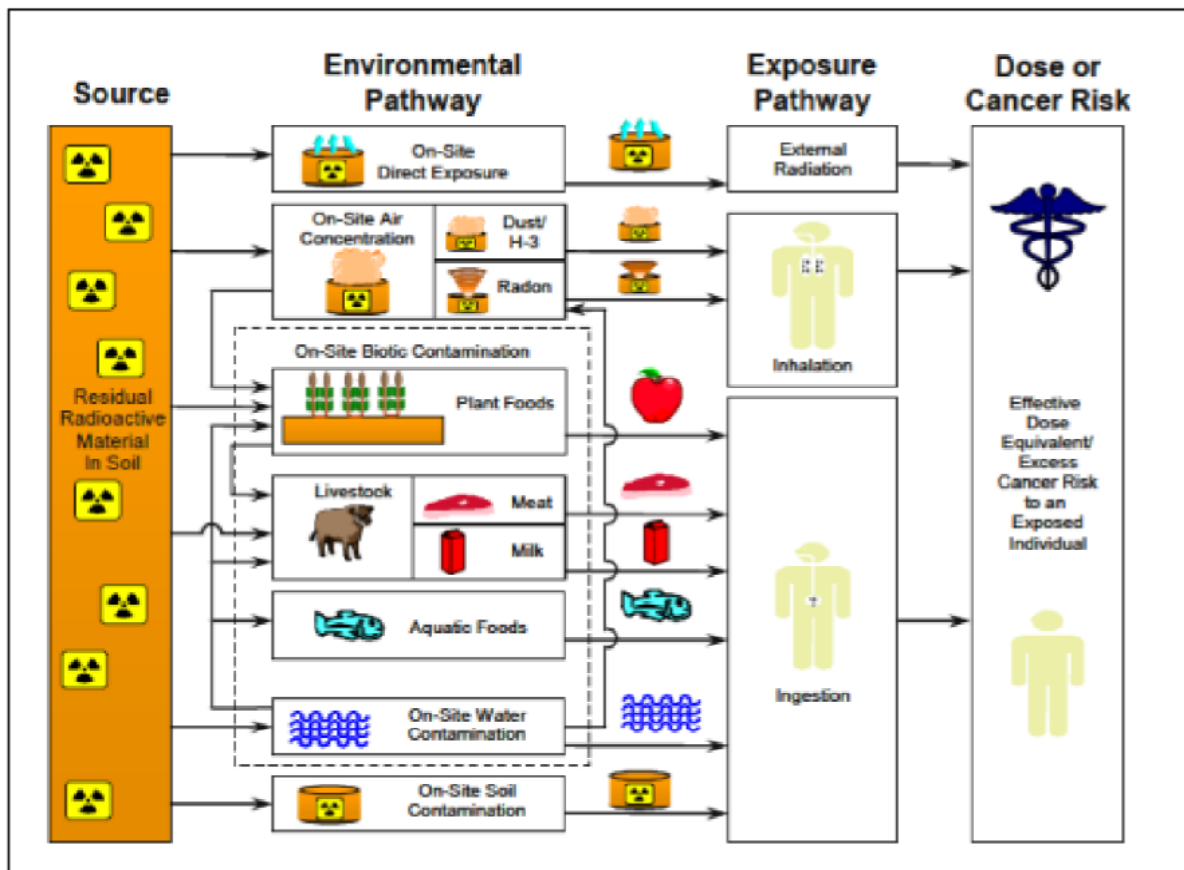


Figure 6-4: Potential exposure pathways to exposed individuals (source: Yu et al, 2001))

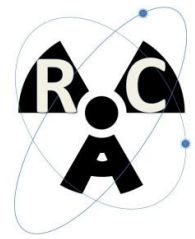


Table 6-7: Pathways and occupancies selected for RESRAD modelling.

Project phase	Operations/Rehab	Post-closure
Pathway	Scenario 1	Scenario 2
	Exposure to study boundary during operations	Residential Farmer
External Gamma	✓	✓
Dust Inhalation	✓	✓
Plant Ingestion	✓	✓
Meat Ingestion	✓	✓
Milk Ingestion	✓	✓
Aquatic Foods	✓	✓
Drinking Water	Assessed separately	
Soil Ingestion	✓	✓
Radon Inhalation	✓	✓
Occupancy (fraction of time)	0.95 (50% indoors; 45% outdoors)	0.95 (50% indoors; 45% outdoors)

6.6.4 Operations/rehab phase – Scenario 1

Scenario 1 represents an operations phase scenario.

Assumptions

It was assumed that a resident would spend 95% of their time directly on a property on the Osprey project boundary (50% of time in a dwelling, 45% of time on the land), and that the soil top 10mm of soil was contaminated on the surface due to mixing. Ingestion of plants and animals from the immediate area is assumed to make up the resident’s diet, however groundwater at the site is not consumed. Ingestion of rainwater is considered as a separate calculation.

Results

Calculated doses for each pathway and the combined maximum dose for Scenario 1 are shown in Table 6-8.

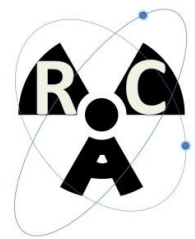


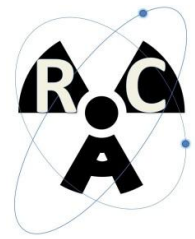
Table 6-8: RESRAD exposure results for Scenario 1 (Operations/rehab phase)

Pathway	Dose from land
Year of max dose (year)	0
Gamma at max year (mSv/year)	0.00698
Dust at max year (mSv/year)	0.00003
Radon at max year (mSv/year)	0.00350
Soil at max year (mSv/year)	0.00019
Drinking Water at max year (mSv/year)	N/A
Fish Ingestion at max (mSv/year)	N/A
Plant Ingestion at max (mSv/year)	0.01272
Meat Ingestion at max (mSv/year)	0.00074
Milk Ingestion at max (mSv/year)	0.00086
Max Dose (mSv/year)	0.02503
Occupancy (fraction of time)	0.95 (50% indoors; 45% outdoors)

Calculated doses are well below the member of public dose limits, with the majority of dose from gamma and radon.

Management

No restrictions on land use are recommended based on the doses estimates.



6.6.5 Post-closure phase – Scenario 2

Assumptions

The project mine closure strategy is return the Osprey Project area to native vegetation, consistent with the pre-mining land use. However, for the purposes of modelling a worst-case scenario for demonstration purposes, the model assumes the post-mining land use is residential farming.

It was assumed that a farmer would spend 95% of his/her time directly on the study area soil (50% of time in a dwelling, 45% of time on the land, and that the soil was contaminated to 5m below the soil surface due to mixing during rehabilitation phase (also allowing radon entry under foundations for a home built on the site). Ingestion of plants and animals from the study area is assumed to make up the farmer’s diet, however groundwater at the site is too saline for consumption.

Results

Calculated doses for each pathway and the combined maximum dose for Scenario 3 are shown in Table 6-9 below.

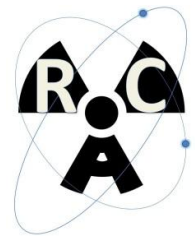
Table 6-9: RESRAD exposure results for Scenario 2 (post-closure phase)

Pathway	Dose from land
Year of max dose (year)	0
Gamma at max year (mSv/year)	0.01137
Dust at max year (mSv/year)	0.00002
Radon at max year (mSv/year)	0.00426
Soil at max year (mSv/year)	0.00011
Drinking Water at max year (mSv/year)	N/A
Fish Ingestion at max (mSv/year)	N/A
Plant Ingestion at max (mSv/year)	0.00172
Meat Ingestion at max (mSv/year)	0.00014
Milk Ingestion at max (mSv/year)	0.00016
Max Dose (mSv/year)	0.01722
Occupancy (fraction of time)	0.95 (50% indoors; 45% outdoors)

Calculated doses are well below the member of public dose limits. The total dose rate includes a significant portion from radon gas inhalation. It should be noted that as the RESRAD model was developed in the US, the radon dose pathway would be an overestimate for Australia in a residential scenario. Due to climatic conditions in America, houses are built to insulate against temperature fluctuations, thereby allowing radon build-up within dwellings. Further to this, a large proportion of houses in America have basements built into the underlying rock formation, thus further enhancing the build-up and containment of radon gas. Within the Australian landscape, houses are typically open and airy with good ventilation.

Management

No restrictions on land use are recommended based on the doses estimated.



6.6.6 Rainwater ingestion

The potential radiological doses to members of the public from the ingestion of rainwater contaminated by atmospheric deposition of project-derived radionuclides is not covered adequately in RESRAD. This pathway is particularly relevant in rural Australian settings, where rainwater is commonly harvested for domestic use, including drinking. The assessment of rain water doses has been conducted from first principles.

The assessment uses a conservative worst-case residential receptor, consistent with other exposure scenarios. This receptor assumes a house is built in close proximity to the mine boundary and assumes rainwater is harvested from a rooftop tank system. The focus is on uranium²³⁸ and thorium²³², along with associated daughter products, consistent with radionuclides present in project-related emissions.

The dose from ingestion of rainwater is calculated using the following steps:

1. Estimate atmospheric deposition rate of radionuclides (Bq/m²/day).
2. Estimate accumulation of radionuclides on rooftop surface area (m²).
3. Determine fraction of deposited activity that is washed into the tank (assumed 100% for conservatism).
4. Calculate activity concentration in the rainwater tank (Bq/L).
5. Estimate annual dose using ingestion dose coefficients (mSv/Bq).

Assumptions:

- Roof area: 150 m²
- Rainfall: 500 mm/year (0.5 m/year)
- Annual water collection: 150 m² × 0.5 m = 75,000 L/year
- Drinking water intake: 2 L/day = 730 L/year
- Deposition rate (at DG13, based on maximum dust deposition measured) = 7.4 g/m²/month
- Deposition activity concentration = 0.0682 Bq/g Th²³² and 0.0117 Bq/g U²³⁸ (based on Hivol data)

Deposited activity/m²/y:

- U²³⁸ and relevant associated daughters: 1.04 Bq/m²/y
- Th²³² and relevant associated daughters: 6.06 Bq/m²/y

Combined dose conversion factors (ICRP 119, for adults):

U²³⁸ series U²³⁸ → Th²³⁴ → Pa^{234m} → U²³⁴ → Th²³⁰ → Ra²²⁶ → Pb²¹⁰ → Po²¹⁰ = **2.8 × 10⁻⁷**

Th²³² series Th²³² → Ra²²⁸ → Ac²²⁸ → Th²²⁸ → Ra²²⁴ → Pb²¹² → Bi²¹² → Tl²⁰⁸ = **5.7 × 10⁻⁷**

Dose Calculations:

Step 1: Total annual deposition on roof:

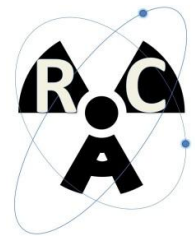
U²³⁸ series: 1.04 Bq/m²/y × 150 m² = 156 Bq/year

Th²³² series: 6.06 Bq/m²/y × 150 m² = 909 Bq/year

Step 2: Activity concentration in tank:

U²³⁸ series: 156 Bq / 75,000 L = 0.0021 Bq/L

Th²³² series: 909 Bq / 75,000 L = 0.0121 Bq/L



Step 3: Annual ingestion activity:

$$U^{238}: 0.0021 \text{ Bq/L} \times 730 \text{ L} = 1.533 \text{ Bq}$$

$$Th^{232}: 0.0121 \text{ Bq/L} \times 730 \text{ L} = 8.83 \text{ Bq}$$

Step 4: Dose:

$$U^{238}: 1.533 \text{ Bq} \times 2.8 \times 10^{-7} \text{ Sv/Bq} = 4.3 \times 10^{-7} \text{ Sv} = 0.00043 \text{ mSv}$$

$$Th^{232}: 8.83 \text{ Bq} \times 5.7 \times 10^{-7} \text{ Sv/Bq} = 5.0 \times 10^{-6} \text{ Sv} = 0.0050 \text{ mSv}$$

$$\text{Total dose from rainwater ingestion} = 0.00043 + 0.0050 = 0.00543 \text{ mSv/year}$$

Under conservative assumptions, the estimated dose to a resident drinking rainwater potentially contaminated by project-derived radionuclides is approximately 0.00543 mSv/year. Even if dust deposition averaged the internal site constraint of 10 g/m²/month, doses would be approximately 0.00734 mSv/year.

Both examples are:

- Significantly lower than the public dose limit of 1 mSv/year
- Based on conservative assumptions (100% wash-in, no decay or loss, continuous ingestion)

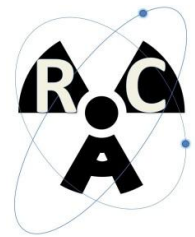
This result confirms that rainwater ingestion is not a significant exposure pathway in the context of the Osprey Project. Nevertheless, it is included for completeness given regional water supply practices.

6.6.7 Summary of modelled impacts to members of the public

Table 6-10 below summarises the calculated doses for each modelled scenario.

Table 6-10: Summary of calculated doses for each scenario modelled in RESRAD.

	Operations/rehab	Post-closure
Pathway	Scenario 1	Scenario 2
	Exposure to nearest potential residential property	Residential Farmer
	Dose from land	Dose from land
Max Dose (mSv/year)	0.02503	0.01722
Rainwater Max Dose (mSv/year)	0.000622	-
Combined Max Dose (mSv/year)	0.02565	N/A



7 CUMULATIVE IMPACTS

To assess cumulative impacts, nearby mineral sands projects with radiological potential were identified. The key project is the Cataby Mineral Sands Mine, operated by Iluka Resources, located approximately 20-25 km from the Cooljarloo Mine, based on the proximity of Cataby to Cooljarloo. Other projects, such as those in Dongara (347 km away), Busselton (around 350-400 km away), and North Dandalup (around 200 km away), are too distant for significant cumulative impacts. It should be noted that a significant cumulative impact comes from Cooljarloo operations (since 1989), which has been included in the assessments conducted. This section relates specifically to cumulative impacts from other sites not directly included in modelling results.

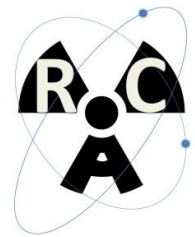
7.1 Cumulative radiological impacts on members of the public

The assessment of public health impacts involves estimating radiological doses from the Osprey extension and adding them to doses from the Cataby Mine. The Cataby Mine's maximum public dose during operations is estimated to be below 0.1 mSv/year, well below the ICRP limit of 1 mSv/year. For the Cooljarloo Mine, which includes the Osprey extension, calculated doses are less than 0.1 mSv/y for all scenarios. Given that doses are <0.1 mSv/y for both projects, and the 20-25 km separation, the cumulative impact on public health is considered negligible.

7.2 Cumulative Radiological Impacts on Non-Human Biota

The ERICA Tier 2 assessment indicates maximum dose rates to NHB from Osprey Project operations (including cumulative Cooljarloo operations, past and present) are well below the 10 μ Gy/h screening threshold. Dust deposition, the primary radiological pathway, peaks at DG13, decreasing sharply with distance. Similarly, for the Cataby Mine, maximum dose rates to NHB are well below the 10 μ Gy/h screening threshold, with dust deposition as the primary radiological pathway, peaking at nearby receptors but decreasing sharply with distance.

Cataby Mine, at 20-25 km, is sufficiently distant to minimize additive effects from dust deposition or other pathways. Other projects are even farther, further reducing potential cumulative impacts. Given the low individual dose rates, rapid attenuation with distance, and limited operational overlap (considering the projects' timelines), cumulative impacts on NHB are considered negligible. No species-specific dose rates are expected to approach the screening thresholds, even under worst-case assumptions of concurrent dust emissions.



8 SUMMARY OF MITIGATION, MONITORING & CONTINGENCY MEASURES

The operational Radiation Management Plan (2023) outlines control, monitoring, and contingency measures, aligning with State Radiation Protection Regulations and the Mining Code requirements (ARPANSA 2005). Whilst the current Radiation Management Plan (2023) does not yet include the Osprey extension, it is proposed to include Osprey further into the approvals process.

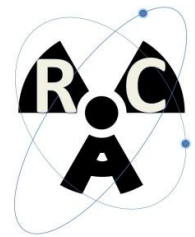
8.1 Mitigation measures

Suggested mitigation measures specifically for the Osprey project are:

- Focus dust suppression efforts on stockpiles, haul roads, and disturbed areas.
- Progressive Rehabilitation: Rehabilitate disturbed areas as early as possible to reduce long-term dust and erosion risks.
- Monitoring and Maintenance of Dust Controls: Regularly inspect and maintain dust suppression systems and coverings, adjusting based on weather and operational conditions.

Suggested mitigation measures for the greater Cooljarloo operations that interface with the Osprey Project are:

- Maximise Dust Suppression near stockpile activities: Apply dust suppression methods such as water sprays, crusting agents, or chemical stabilisers, particularly over exposed areas.
- Surface Stabilisation of Waste Areas: Apply surface stabilisation treatments on waste and stockpile areas, especially for materials with elevated radionuclide concentrations.



8.2 Monitoring

The environmental radiation monitoring program for the project is outlined in Table 8-1 below.

Table 8-1: Osprey environmental radiation monitoring program

Pathway/parameter	Measurement method	Location	Frequency
Gamma dose rate (external)	Handheld gamma dose rate meter	HMC stockpiles	6 monthly
		Site boundaries/rehab areas	Annually
Radon and thoron progeny in air	Long term passive detectors	Established radon monitoring locations	Changed quarterly
Radionuclides in groundwater	Groundwater sampling, analysis of samples for radionuclides	Established monitoring bores	Varies
Radiation in airborne dust	Positional dust sampling	HMC stockpiles/MRF	6 monthly
	High Volume Air Sampler (HVAS) monitoring, analysis of filter papers for alpha radiation	Monitoring sites established at suitable reference locations	Quarterly

8.3 Contingency measures

Suggested contingency measures for include the establishment of dose constraints within the Operational Radiation Management Plan, set with the conservatively modelled dose predictions in this report in mind. These constraints will act as operational targets, ensuring that actual radiation exposures remain well below regulatory limits. Should monitoring indicate that doses are approaching these constraints, corrective actions such as enhanced dust suppression, operational adjustments, or additional containment measures should be implemented to maintain radiation protection standards.

9 SUMMARY OF IMPLICATIONS UNDER RELEVANT LEGISLATION

9.1 Environment Protection and Biodiversity Conservation Act 1999 (Cwth)

The Osprey Project may constitute a nuclear action under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), as the Osprey Project involves the handling of mineral sands containing elevated concentrations of naturally occurring radionuclides (uranium and thorium and their decay products), see Table 9.1 for nuclear action descriptions. Based on supplied activity concentrations for the HMC, this materials exceed the exemption thresholds outlined in the EPBC Regulations Schedule 4 (exceeds 1 Bq/g for the Th-232 series).

The Osprey Project is proposed to be referred under the EPBC Act. This Radiation Impact Assessment supports the consideration of radiological risks to both human health and non-human biota as part of that referral.

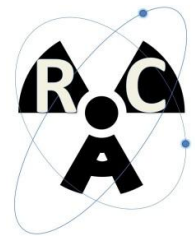


Table 9.1: Nuclear action descriptions

Nuclear Actions outlined in the EPBC Act	Osprey project
(a) establishing or significantly modifying a nuclear installation	Not proposed
(b) transporting spent nuclear fuel or radioactive waste products arising from reprocessing	Not proposed
(c) establishing or significantly modifying a facility for storing radioactive waste products arising from reprocessing	Not proposed
(d) mining or milling uranium ore;	Not proposed
(e) establishing or significantly modifying a large-scale disposal facility for radioactive waste	Not proposed
(f) de-commissioning or rehabilitating any facility or area in which an activity described in paragraph (a), (b), (c), (d) or (e) has been undertaken	Not proposed
(g) any other action prescribed by the regulations: <ul style="list-style-type: none"> R2.01 For paragraph (g) of the definition of nuclear action in subsection 22(1) of the Act, a nuclear action includes establishing, significantly modifying, decommissioning or rehabilitating a facility where radioactive materials at or above the activity level mentioned in regulation 2.02 are, were, or are proposed to be used or stored. 	HMC will be produced at the Osprey Project. HMC exceeds the exemption thresholds outlined in the EPBC Regulations Schedule 4 (exceeds 1 Bq/g for the Th-232 series).

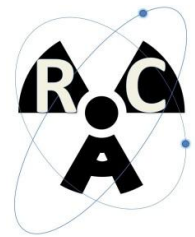
9.2 Radiation Safety Act 1975 (WA)

The Radiation Safety Act 1975 (WA) governs the possession, use, and disposal of radioactive substances in Western Australia. Based on the measured and reported concentrations of radionuclides in Osprey HMC it is considered radioactive substances under the Act and the associated Radiation Safety (General) Regulations 1983, which define thresholds for licensing and control.

Accordingly, Tronox is required to:

- Hold a Radiation Management Licence for the handling and processing of HMC;
- Ensure compliance with occupational and public dose limits in accordance with ARPANSA's RPS C-1 Code for Radiation Protection in Mining and Mineral Processing;
- Maintain an approved Radiation Management Plan (RMP) covering the Osprey activities, consistent with the broader Cooljarloo operations;
- Apply optimisation (ALARA) principles for all exposures;
- Ensure radiation protection for workers, the public, and the environment during the operational and post-closure phases.

Materials generated from the Osprey Project, including process residues (sand tails and clay fines) , will be managed within the existing licenced framework at Cooljarloo. No processing or stockpiling of HMC will occur within the Osprey area.



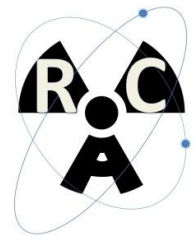
10 CONCLUSIONS

Dose estimates to members of public entering the Osprey project site during operational phases are below the member of public dose limit (1 mSv/year). Doses are considered highly conservative, given that no shielding or air filtration is considered for sitting in vehicles, and occupancy factors for members of the public are over-estimated for an intrusion event.

Dose estimates to members of the public due to the worst case post closure scenario are below the member of public dose limit of 1 mSv/year, and comparable to the dose received from a short haul domestic flights in Australia. Public doses are considered highly conservative, given that consumption of food from the local area is likely over estimated, given that it is unlikely that all food could be sourced from the areas that represent the areas of greatest radiological uptake, and given that radon exposures in Australia are typically lower than calculations predict (based on RESRAD data originating from the USA).

No RAP or user defined animal or plant received a dose of above the screening “no effect” dose rate of 10 μ Gy/h. This indicates that there are no effects from a radiological perspective due to planned operational activities. Modelled external dose rates from covered tailings are negligible, indicating that there are likely to be no impacts from a radiological perspective to NHB due to continued mining, processing, and stockpiling of Osprey ore, products and wastes.

The assessment has shown that the proposed operations at Osprey, including cumulative doses in association with past and present operations at the adjacent Cooljarloo Mine, will result in doses below the public dose limit to members of the public, with no significant effects to humans as a result, and under the “no effect” screening threshold for NHB. Post-closure doses will also be well below the members of the public dose limit, and the “no effect” threshold for NHB. There are no concerns regarding cumulative radiological impacts to the site from other surrounding operations due to the low doses associated with the project, and the distance to sites with the potential for cumulative radiological impacts.



APPENDIX A - REFERENCES

AAEC, 1985, Australian Atomic Energy Commission Research Establishment Lucas Heights Research Laboratories, Options for clean-up of the Maralinga test site, Environmental Science Division, June 1985

ARPANSA, 2010, Environmental Protection: Development of an Australian approach for assessing effects of ionising radiation on non-human species, Technical Report Series No. 154, Australian Radiation Safety and Nuclear Safety Agency

ARPANSA, 2014, A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments, Technical Report 167, Australian Radiation Safety and Nuclear Safety Agency

ARPANSA, 2015, Radiation Protection of the Environment, Radiation Protection Series G-1 Australian Radiation Safety and Nuclear Safety Agency

Cheng, JJ,, Yu, C., 1993, Using the RESRAD Computer Code to Evaluate Human Health Risks from Radionuclides and Hazardous Chemicals

Department of Energy (US), 2003, A Compendium of Transfer Factors for Agricultural and Animal Products

Environment Protection and Biodiversity Conservation (EPBC) Act, 1999

ERICA, 2021, ERICA Assessment Tool Help, 28 Oct 2021 version

Hirth, G.A., et al., Whole-organism concentration ratios in wildlife inhabiting Australian uranium mining environments, Journal of Environmental Radioactivity (2017), Accessed April, 2025
<http://dx.doi.org/10.1016/j.jenvrad.2017.04.007>

IAEA, 2010, Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments, Technical Reports Series No. 472

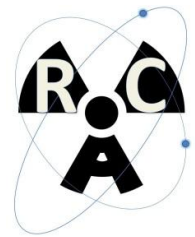
IAEA, 2004, Safety Assessment Methodologies for Near Surface Disposal Facilities, IAEA Vienna

ICRP, 1991, Recommendations of the International Commission on Radiological Protection ICRP Publication 60

ICRP, 2012, Compendium of Dose Coefficients based on ICRP Publication 60, ICRP Publication 119, Annals of the ICRP 41 (s)

ICRP, 2014, Protection of the environment under different exposure situations. ICRP Publication 124, Annals of the ICRP 43 (1): 58

Kachenko, A.G and Singh, B., 2006, Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia, Water, Air and Soil Pollution, Volume 169, Issue 1, pp 101-123



Kaste, J.M., Heimsath, A.M., and Bostich, B.C., 2007, Short-term soil mixing quantified with fallout radionuclides, *Geology*, vol. 33

Radiation Management Plan (NOPS), 2023, Tronox

Reid J and Pickering R, 1999, Ecological and Toxicological Effects of Exposure to an Acidic, Radioactive Tailings Storage, *Environmental Monitoring and Assessment*, January 1999, Volume 54, Issue 1, pp 69–85

Ridoutt, Bradley et al., 2016, Changes in Food Intake in Australia: Comparing the 1995 and 2011 National Nutrition Survey Results Disaggregated into Basic Foods. *Foods (Basel, Switzerland)* vol. 5,2 40. 25 May. 2016, doi:10.3390/foods5020040

UNSCEAR, 1996, Sources and Effects of Ionizing Radiation. United Nations: Vienna, Austria

UNSCEAR, 2000, Report to the General Assembly, Annex B: Exposures from natural radiation sources. 2000, United Nations Scientific Committee on the Effects of Atomic Radiation: New York

Yu et al., 2001, User's Manual for RESRAD Version 6