Ecological Risk Assessment

What is its Value in Risk Based Decision Making?

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OVERVIEW

- What is ERA? – definition and history
- How can ERA help you? – applications
- ERA Methodology
  - Problem Identification
  - Receptor Identification
  - Exposure Assessment
  - Toxicity Assessment
  - Risk Characterisation
- Case Study – Windarra Nickel Project

What is ERA?

Scientifically understood process for
evaluating ecological risks posed
by a particular stressor/contaminant.

Risk assessed through the identification of
contaminants, flowpaths, toxicities, and receptors.

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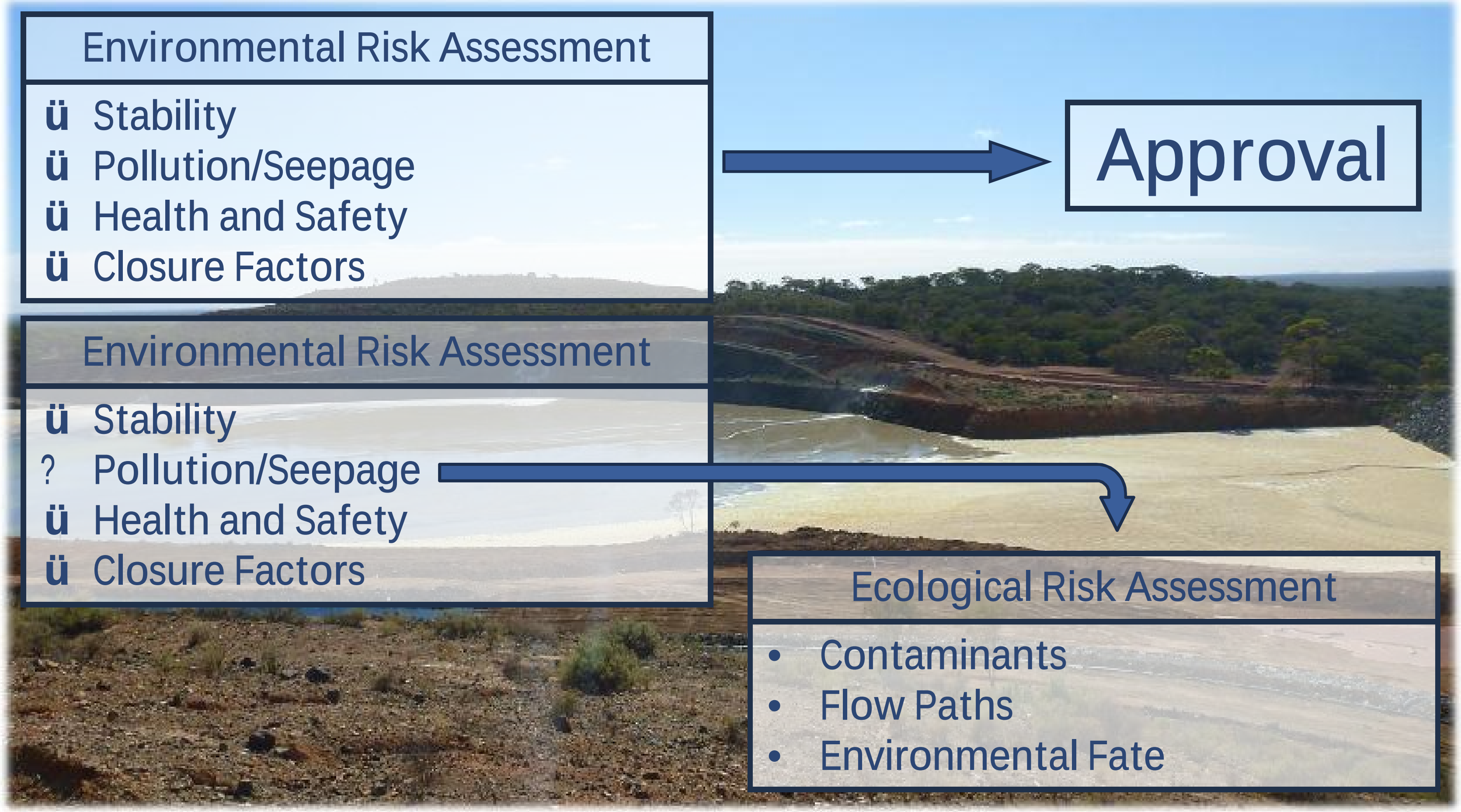
ENVIRONMENTAL VERSUS ECOLOGICAL RISK ASSESSMENT



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ERA History and Implementation

- Ecological risk associated with existing contamination issues.
- Based upon NEPC 1999 methods.
- MBS adopted process as a risk prediction tool.

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How Can ERA Help You?

Project Conception

- Evaluation of design options/process scenarios.
- Technical supporting documentation for project approval documents.

Project Operations

- Design of monitoring programs.
- Guidance on controls required to meet environmental goals during production.
- Assessing various mine management options.

Closure

- Design of post-closure monitoring programs.
- Guidance for environmental controls during closure stages.
- Evaluation of different closure options.

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APPLICATIONS OF ERA

Transport Routes

TSF Locations

Shipping Options

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ERA METHODOLOGY

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1. Problem Identification

Contaminated Waters

Fuel Storage

Product Transport

TSF Seepage

2. Receptor Identification

Playa Lake Ecosystems

Fringing woodland

Halophyte communities

Salt lake micro and macroinvertebrates

Ephemeral Creek Ecosystems

Vegetation communities

Livestock

Rare and endangered flora and fauna

Aquatic communities

Water Resources

Pastoral station residents

Town water supply

Cattle

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3. Exposure Assessment

Medium	Flow Path	Exposure Mechanism
Air	Wind, airborne dust etc	Inhalation
Groundwater	Palaeochannels, leaching, seepage etc	Ingestion, dermal contact
Surface Water	Creeks and lakes	Ingestion, dermal contact
Soil	Soil pore water, adsorption, capillary rise	Ingestion, dermal contact

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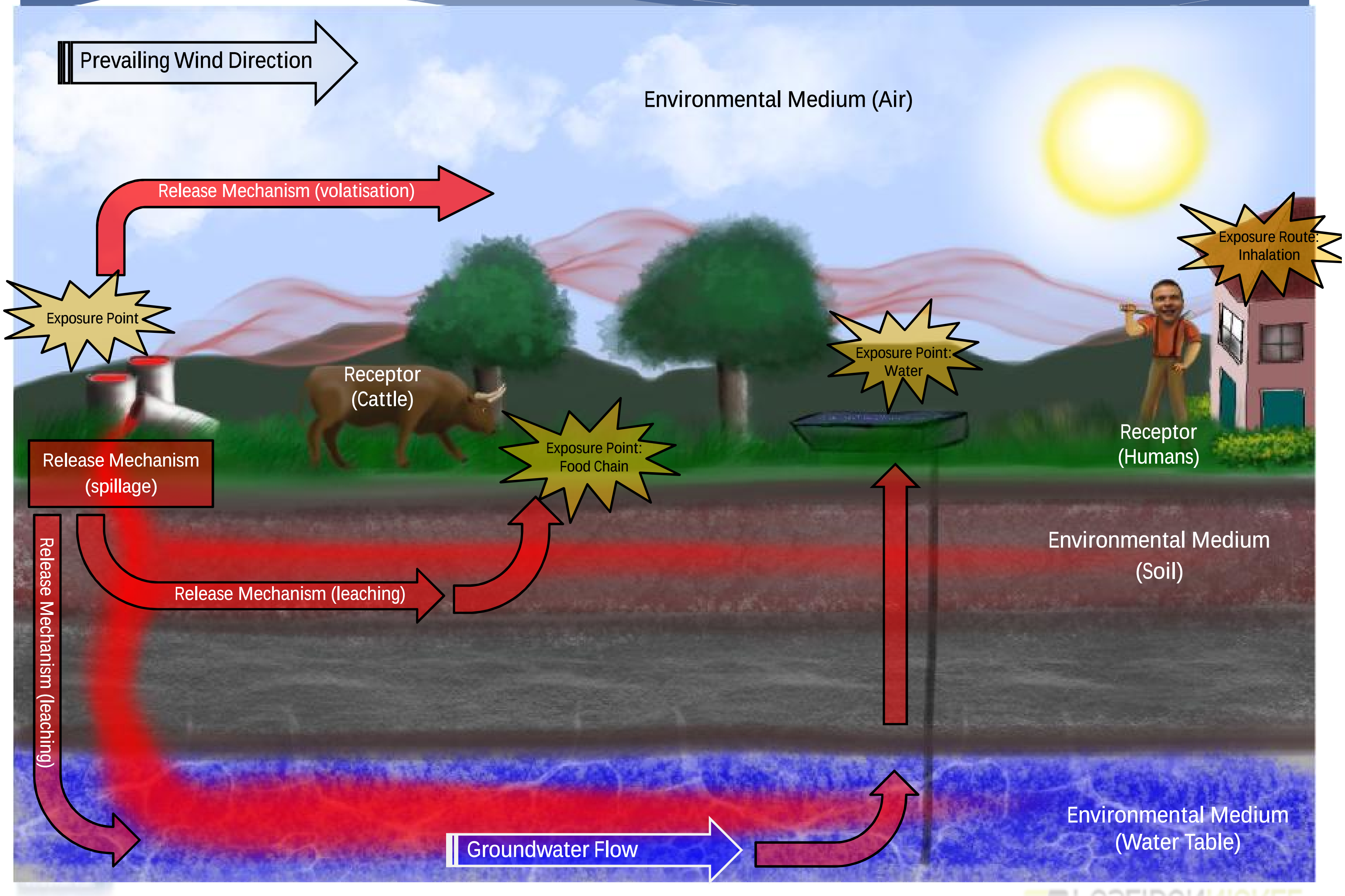
CONCEPTUAL SITE MODEL (CSM)



4. Toxicity Assessment

5. Risk Characterisation

Likelihood

Descriptor	Description
Almost certain	Is expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possibly	Will probably occur in some circumstances
Unlikely	Could occur at some time
Rare	May occur in only exceptional circumstances

Consequence Criteria

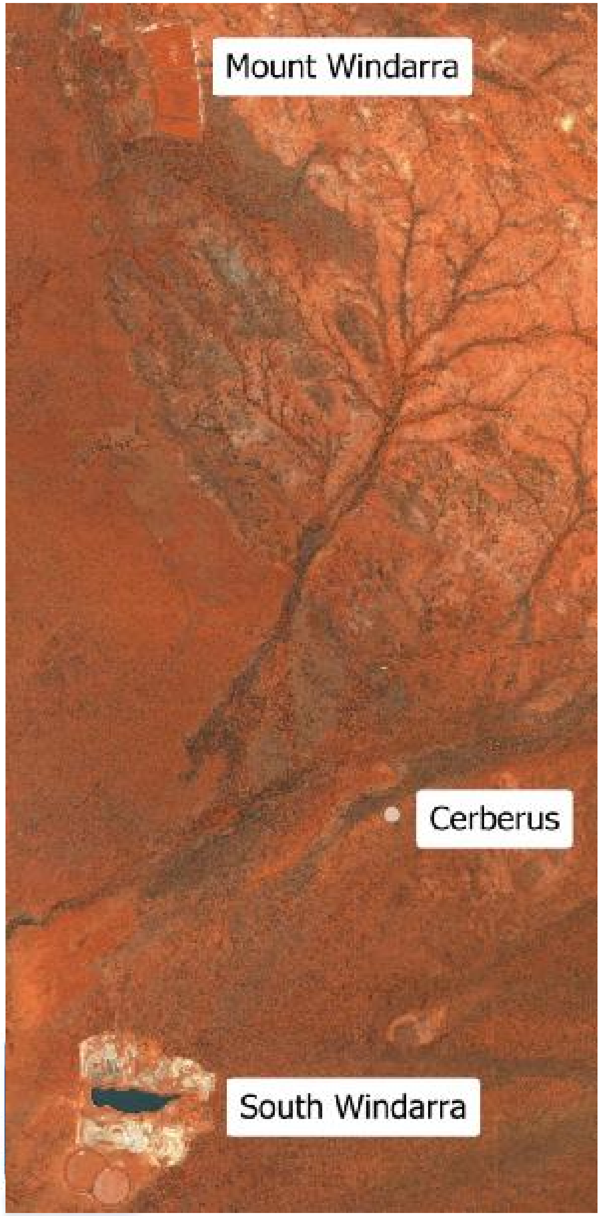
Descriptor	Description
Insignificant	No measurable environmental impact
Minor	Minor environmental impact in short term
Moderate	Moderate environmental impact in short term
Major	Moderate environmental impact in long term
Severe	Irreparable damage

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	HIGH	HIGH	VERY HIGH	EXTREME	EXTREME
Likely	MEDIUM	HIGH	HIGH	VERY HIGH	EXTREME
Possibly	LOW	MEDIUM	HIGH	HIGH	VERY HIGH
Unlikely	LOW	LOW	MEDIUM	MEDIUM	HIGH
Rare	VERY LOW	LOW	LOW	LOW	MEDIUM

OUTCOMES & RECOMMENDATIONS

- Understanding of ecological risk
- Informs appraisal of options
- Mitigation controls
- Monitoring requirements
- Do nothing J

Case Study – Windarra Nickel Project



- 260 km NNE Kalgoorlie
- Previously operated 1974 -1994
- Approvals for recommencement of:
  - Mount Windarra underground mine
  - Nickel concentrator
  - Gold Tailings Processing
  - Power generation
  - Borefield
  - Ancillary infrastructure
  - Village
- Approvals for Cerberus underground mine
- Approvals for use of South Windarra Pit

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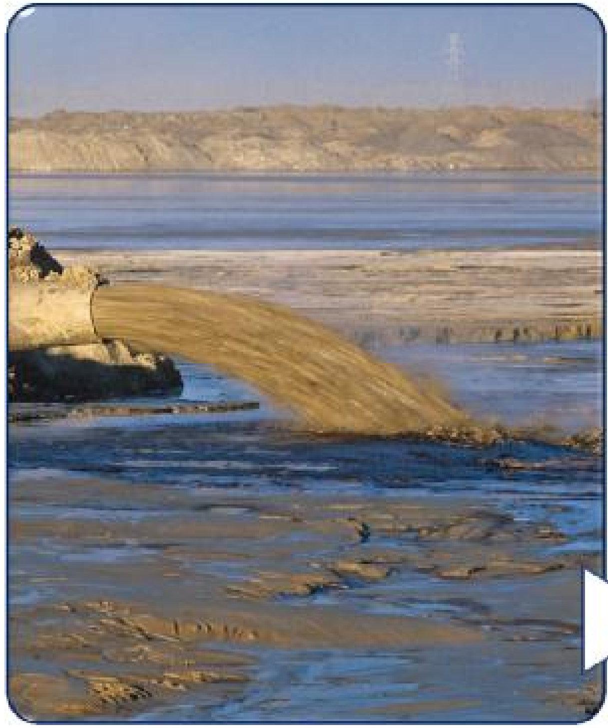
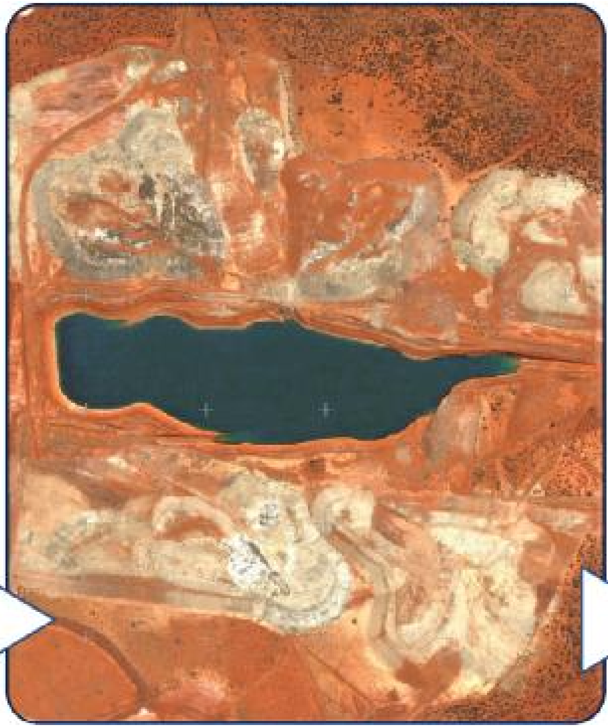
PROBLEM IDENTIFICATION

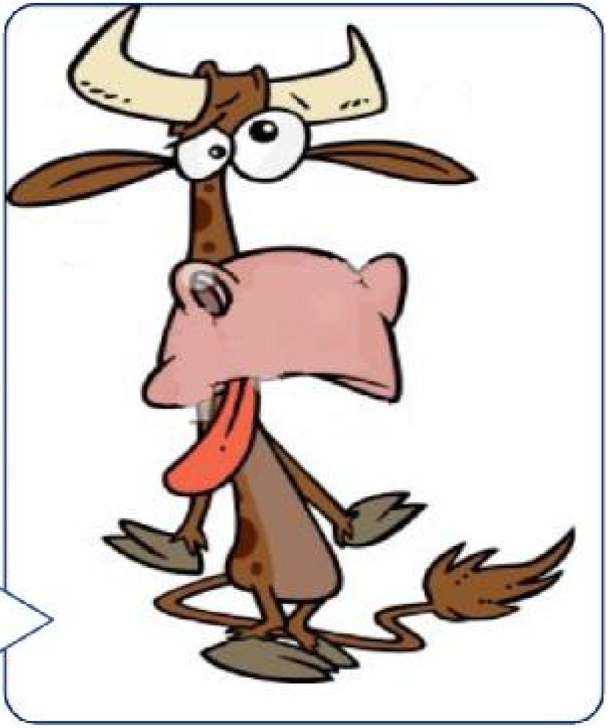
Disposal of Tailings



Pit Lake



Impacts?!



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KEY CONTAMINANTS OF CONCERN

- **Cyanide**
  - Free Cyanide
  - Thiocyanate
  - Cyanate
  - Weak Dissociable (WAD) cyanide-metal complexes
- **Metals and Metalloids**
  - Arsenic
  - Boron
  - Cobalt
  - Cadmium
  - Copper
  - Manganese
  - Nickel
  - Selenium
  - Zinc
- **Inorganic Anions**
  - Nitrate
  - Sulphate

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Receptor Identification

Human Receptors

Native Fauna/Avifauna

Livestock

Native Vegetation

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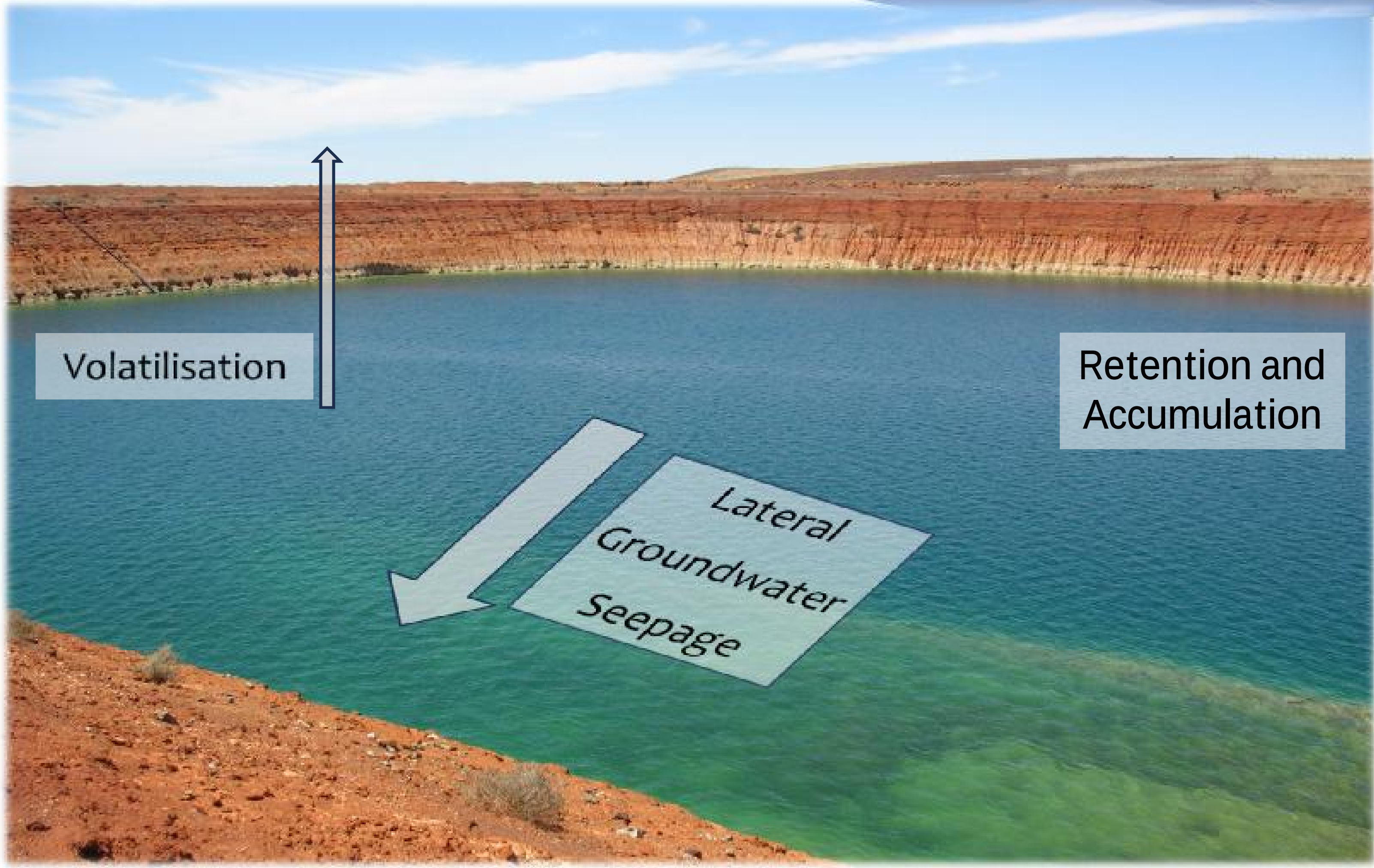
EXPOSURE ASSESSMENT



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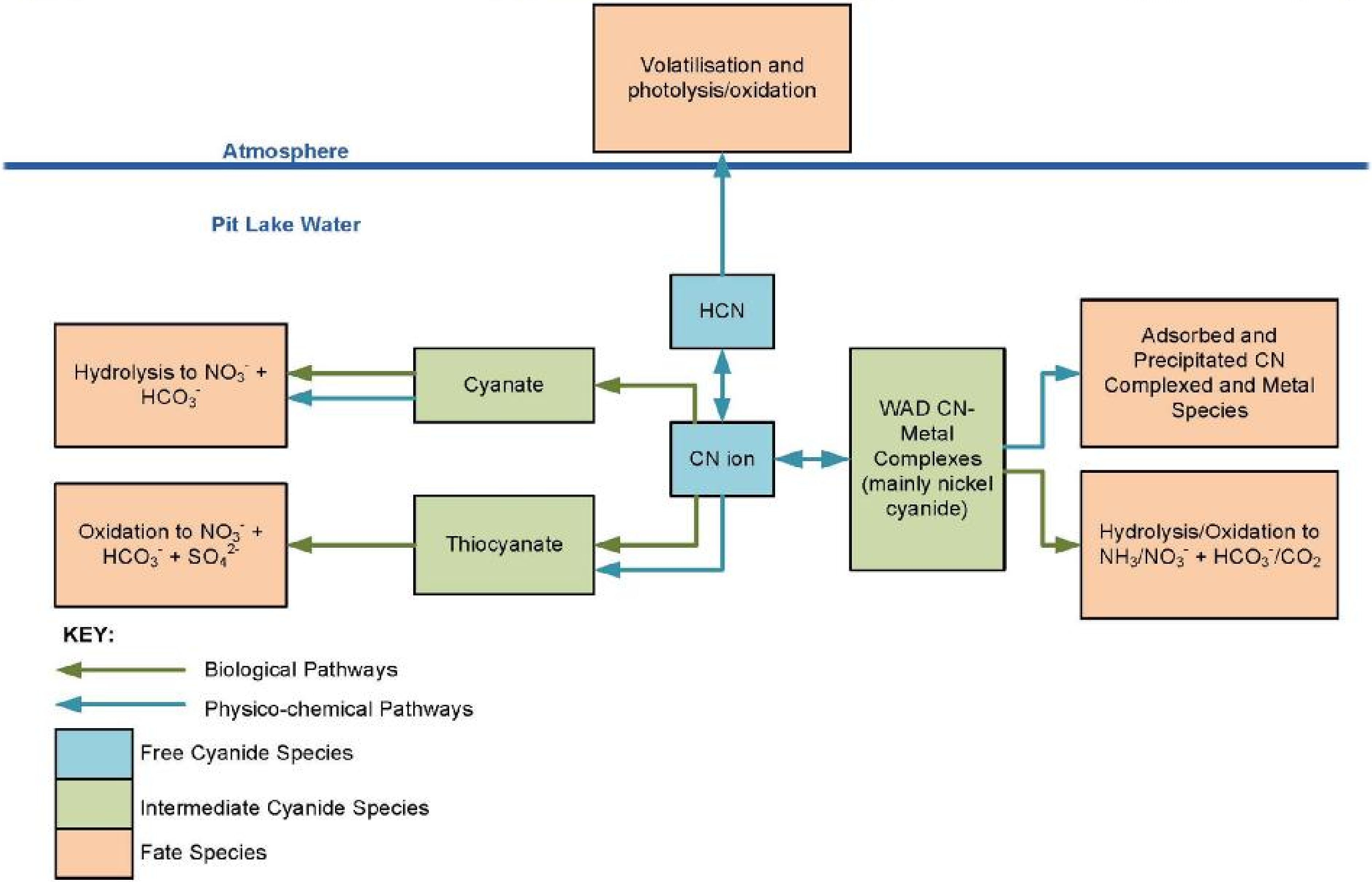
Fate and Transport of Cyanide



Contaminant Exposure Mechanisms

Where: Discharge point & return process water

How: Inhalation and dermal exposure to tailings & return process water

Where: Pit lake surface

How: Inhalation, ingestion and dermal contact with lake water

Where: Stock bores down gradient of pit lake

How: Ingestion of contaminated groundwater

Where: Down gradient of pit lake

How: Root uptake of bioavailable contaminants in groundwater

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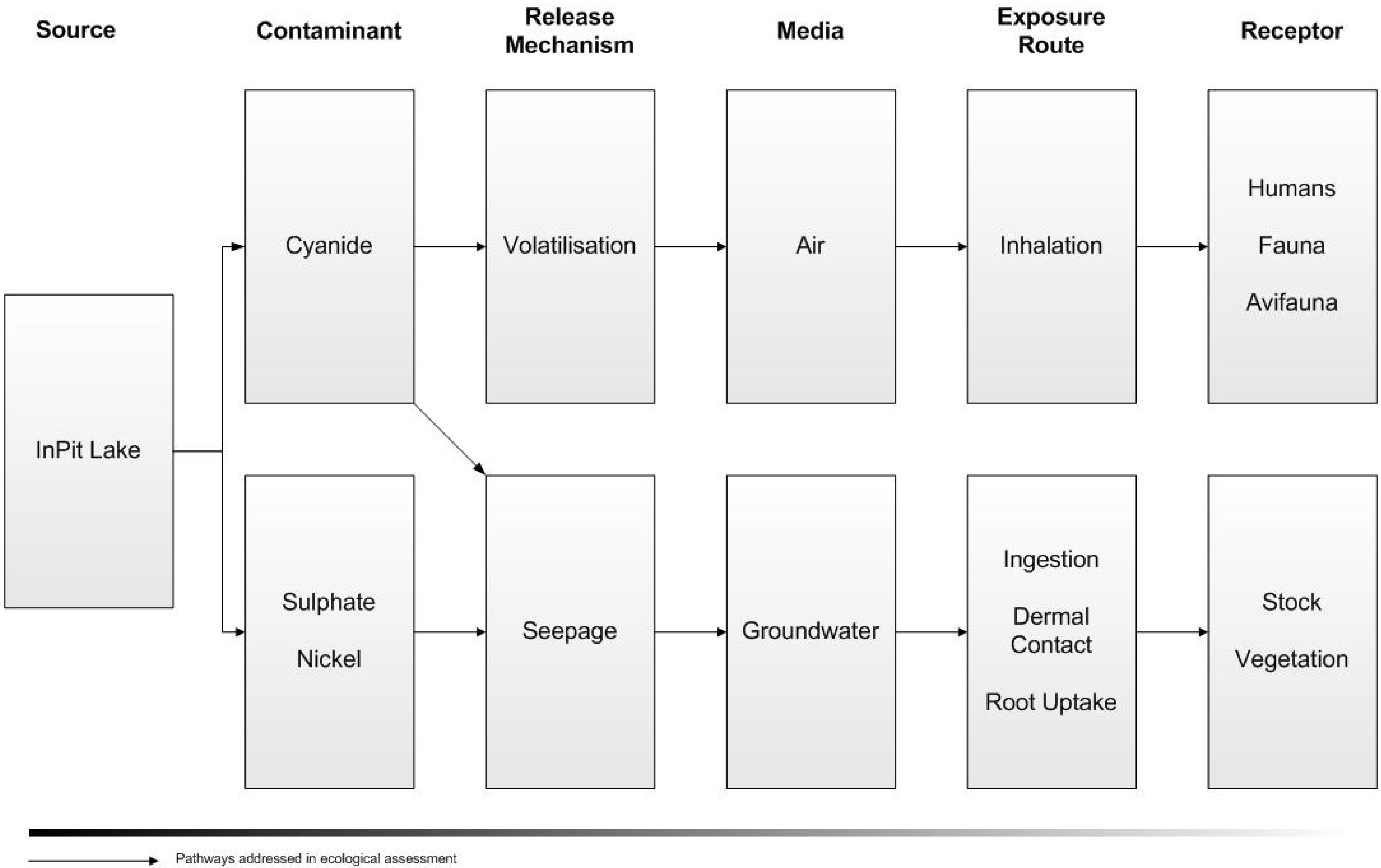
CONCEPTUAL SITE MODEL



Toxicity Assessment

Cyanide

- Non essential element in mammals.
- Readily absorbed and distributed through the body.
- No evidence for biomagnification or cycling.
- Rapidly detoxified by living organisms.

Nickel

- Essential element.
- Respiratory and oral toxicant in high doses.
- Not accumulated in aquatic organisms or mammals.
- Evidence suggests accumulations decrease with increases in trophic level.

Sulphate

- Not a significant threat unless present at very high concentrations.
- Recognised as an environmental stressor.
- No evidence to suggest bioaccumulation or biomagnification in the food chain.

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Risk Characterisation

Receptor	Contaminant	Transport Media	Reception Mechanism	Probability	Basis	Consequence	Basis	Risk
Stock	Free Cyanide	Groundwater, south-west	Ingestion by stock	Rare	Unlikely to migrate to stock bores. Volatilisation likely to restrict detectable concentrations within pit lake.	Insignificant	Will not be present in detectable concentrations in stock water	Very Low
Stock	Arsenic	Groundwater, south-west	Ingestion by stock	Rare	Migration of arsenic to stock bores highly unlikely. Sufficient adsorption to soils.	Insignificant	Predicted to be below livestock drinking water guidelines	Very Low
Tall mulga vegetated areas	Nickel	Groundwater, South-west	Root uptake	Unlikely	Migration of nickel to alluvial aquifers highly unlikely. Sufficient adsorption to soils.	Insignificant	Concentrations unlikely to be much higher than background values	Low

RESULTS

Total of 92 Risk Scenarios

0	VERY HIGH
0	HIGH
0	MEDIUM
46	LOW
46	VERY LOW

ERA RECOMMENDATIONS

- Monitoring at pit lake and groundwater monitoring bores
- Setting site specific trigger values
- Use of hydrogen peroxide or ferric sulphate to reduce free cyanide

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How the Poseidon ERA Informed Decision making

Framework	• For any further modelling and assessment of risks
Operation	• Provide set of practical measures
Approvals	• Provide evidence of assessing risks
Confidence	• Utilising pit lake for tailings disposal
Monitoring	• Provided set of requirements

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CONCLUSIONS

- Invaluable predictive tool
- Identifies key risk issues
- Assesses complex biophysical processes
- Provides confidence to regulators
- Avoids unnecessary studies and monitoring
- Complements traditional environmental risk assessment

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