Worksheet 1
What is Environmental Risk Management?

Question: What does Environmental Risk Management mean to you?

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Worksheet 2

Uncertainty and Hazard Identification: Tailings Dam

Activity or Operation	Possible Initiating Events	Possible Consequences	Available Safeguards
Storage of tailings	Severe storm event	Dam overflow and pollution of downstream waters	• Location of dam to minimise consequences of releases • Conservative design of dam to take account of foreseeable extreme weather events

Worksheet 3
Hazard Identification and Environmental Aspects

- Identify the environmental hazards associated with your mining operation.
- Identify the aspects of the environment that these hazards may impact.
- An example is given to get you started.

Type of Hazard	Environmental Aspect
Fires	Air (dust, smoke, fumes)

Worksheet 4
Case Study: Los Frailes Tailings Dam Failure

The aim of this case study is to help you analyse the consequences of an environmental incident at a mine. In this case a tailings dam failure. Analysing consequences is not just about the end outcomes but also the steps leading to the outcomes.

On April 25, 1998, a tailings dam failure of the Los Frailes lead-zinc mine at Aznalcóllar near Seville, Spain, released 5 to 7 million cubic metres of toxic tailings slurries and liquid into nearby Río Agrio, a tributary of Río Guadiamar. The slurry wave covered several thousand hectares of farmland, and it threatened the Doñana National Park, a UN World Heritage Area.

A foundation failure of a separation dam between two parts of the impoundment initiated the break of the main dam. A slab of soil beneath the dam slid approximately 1 metre towards Río Agrio. The dam cracked and broke and the collapsed wall was swept along the separation dam between the two impoundments. Between 5 and 7 million cubic metres of contaminated water and slurries spilled through the gap. The bed of the Río Agrio rose three metres in height and changed its course. The cleanup costs for the dam failure are estimated at US$ 100-200 million. Mining resumed at Los Frailes in April 1999, however the company has since announced its insolvency and ceased operations from October 2001. The reason for the foundation failure, and the failure of the mine management to foresee the problem is still a matter of discussion, although a number of theories have been proposed.

- The mine operators claim that there was no way to foresee the incident and have subsequently blamed construction contractors for misinterpreting the geotechnical properties of the site.
- A report prepared for the mining company described the weak point of the dam two years in advance of the failure.
- Geotechnical experts suggest that the foundation failure was caused by chemical attack of the impounded acidic pyritic slurries on the marl forming the dam foundation material.
- Other experts suggest that the dam was built on expansive clays which deformed with wetting and drying. They claim that the expansion and contraction of the clays should have been accounted for in the design of the dam. In addition, reports indicate that the subsoil was unsuitable to support the mass of tailings that were piled up in the dam.
- One of four inclinometers, which would have alerted mine management to the problem had not been operational since early 1997 and the three others were not maintained in good condition.
- Acidic seepage, combined with continued blasting in the nearby open pit mine would have contributed to the dam failure.
- Other experts suggest that the dam was designed with insufficient beach width and that the dam was being filled at a rate higher that it was designed for.

Worksheet 4a
Case Study: Los Frailes Tailings Dam Failure

Questions

1. What do you think were the key steps that led to the dam failure?

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2. What was the initiating event for the incident?

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3. What were the consequences of the dam failure?

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4. What were the magnitude, extent, severity and duration of the consequences?

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Worksheet 5
Environmental Risk During the Mining Cycle

- The nature and extent of environmental risk may change during each stage of the mine's life cycle. ERM should be applied to all phases of the mining cycle and all parts of mining operations.
- Identify the environmental risks that are applicable at each stage of the mining cycle.

Mining Phase	Environmental Risk Issue
Planning and Concept Development	• Choice of mining method (open cut or underground • Location and layout of facilities
Exploration	
Approval Processes (including Environmental Impact Assessment)	
Development and Construction	
Operations	
Mine Closure and Rehabilitation	

Worksheet 6
Case Study Questions

1. What environmental hazards can be identified in this case study?

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2. What are the potential environmental consequences of these hazards?

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3. How is/should the risk be assessed?

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4. How was/should risk be treated in this case?

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5. What would be an appropriate management plan in this case?

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6. How was/should the success of the proposed management plan be monitored?

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7. Were there any significant consequences or long-term potential impacts on the environment within the site? What about off-site impacts?

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8. What were the recommendations of the risk analysis process?

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