

MINE CLOSURE

A PRACTITIONER'S PERSPECTIVE

February 2020

Mike Slight

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MINE CLOSURE – A PRACTITIONER'S PERSPECTIVE

- Introductions
- Mine closure score card, my observations
- Mine closure benchmarking – what are we seeing and why?
- Mine closure costing – its not rocket science

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INTRODUCTION

- Mining Engineer of 40+ years
- Site GM for four mines, Closure GM for two mines
- Consultant 10+ years, closure management, cost estimation and closure implementation advice
- University of Qld, SMI Environmental Centre's advisory board
- Inaugural Chair of the WA MRF Advisory Panel
- Community Volunteer –Orange Sky Australia, helping to connect those in need through a free laundry mobile service and conversation
- Traveler– Benchmarking closed mines around the world

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MINE CLOSURE SCORECARD

GENERAL OBSERVATIONS

- Mine footprints growing, TSF's getting bigger
- Increasing community knowledge and expectations
- Minimal investment in closure related R&D
- Operational decisions, production focus
- The real cost to close not fully understood
- Closure planning governance developing
- Divestment of liability at closure still happening
- Benchmarking to improve understanding

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MINE CLOSURE SCORECARD

REGULATORY OBSERVATIONS

- Zero liability to the State
- Increasing prescriptive regulations
- Increasing expectation of long post closure monitoring periods
- Levies to deal with abandoned mine legacies
- Financial assurances, +100% bonding using regulator calculators
- Regulator sign off unlikely without effort

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MINE CLOSURE BENCHMARKING

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WATER MANAGEMENT A LONG TERM RISK

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Water management
during operations - focus
is on operational and
processing supply

Water
management
at closure

Downstream
impacts – off
lease

Water storage
and pit lake
water quality –
public safety

Tailings
seepage – in
perpetuity
management

Acid Rock
(Mine)
Drainage
impact to the
environment

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Managing water during operations critical for closure.
Often the biggest issue to deal with both during operations and at closure.
Surface water quality and quantity impacts down stream
Pit Lake and water storage quality issues
Acid mine drainage waste dump and tailings dam construction
encapsulation and closure cover design and performance
tailings dam seepage management
down
stream surface impacts to soils and vegetation

EROSION AND SURFACE STABILITY

Landform stability relies on mine engineering design and construction performance during operations

Recognising and managing rehabilitation materials – growth medium topsoils, rock armour, NAF material etc.

Managing problematic material types – PAF, dispersive and sodic materials

Design and managing landform during construction to avoid surface water issues

Avoiding steep and long slopes on high dumps

Minimise soil loss and downstream impacts

Tails deposition and decant water management

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OTHER RISKS - LONG TERM ISSUES

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Management of other risks during operations impact on mine closure

long term remediation of contaminated soils

decommissioning and demolition of mine infrastructure

under ground mining methods

WHY DO WE SEE THESE CLOSURE OUTCOMES?

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 Underestimating the costs at closure

 Integrating closure planning within operations decision making processes

 Little to no engineering and design for closure

 Lack of closure experience and/or competencies

 Corporate commitment lacking

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No sense of ownership of closure cost liabilities by operations personnel - "leave it to the environmental department"

Lack of experience and/or competencies of estimators and high turnover of professionals, supervisors and operators

Lack of regulator pressure to close progressively

Transfer of closure liability through sale of asset – easy out

Inadequate understanding and knowledge of site characteristics

Little to no engineering and design

MINE CLOSURE COSTING, IT'S NOT ROCKET SCIENCE

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CLOSURE COST ESTIMATING ISSUES

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Increased disturbance and infrastructure not captured



Basis of engineering and design not established early enough



Closure implementation strategy not considered in detail



Investigations and studies not undertaken to inform closure plan and costings



Closure risks (and opportunities) not adequately understood

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Closure cost estimates for most mining operations are unlikely to represent the true cost as they near closure due to:

- Increased disturbance and infrastructure not accounted for and/or underestimated in costs to close
- Bases of engineering design not established
- Not fully understanding the closure implementation strategy owner versus contractor (EPCM, EPC, Owner)
- Closure costs not including items required
- No allowances for unknown environmental impacts (risk management)

CLOSURE COST ESTIMATING ISSUES

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No sense of ownership by operations – environmental responsibility



Lack of experience and/or competencies of estimators



Unrealistic equipment selection and productivities



Cost estimation governance not established



Inadequate understanding and/or knowledge of site characteristics

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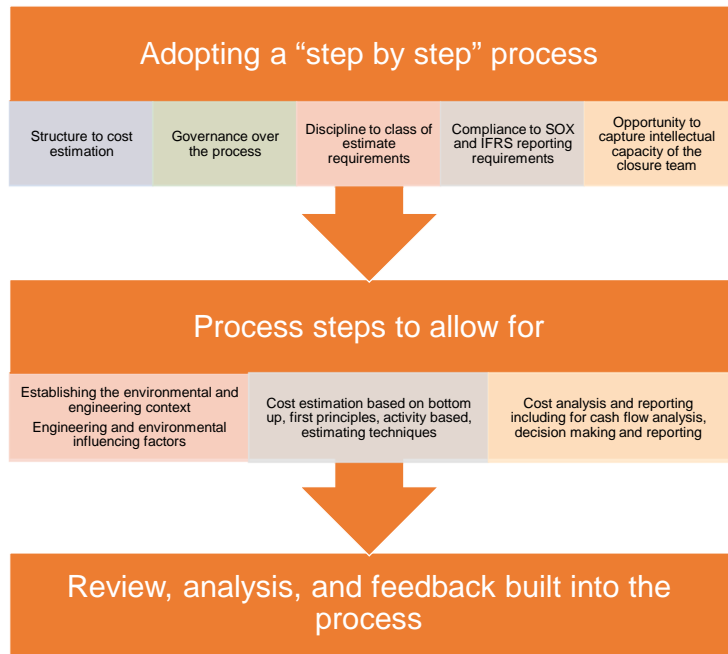
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Cost Estimating - A Step by Step Process

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COST ESTIMATING PROCESS – INPUTS AND OUTPUTS

- Inputs**
- Closure domain data
 - Environmental data
 - Infrastructure details
 - Design specification
 - Engineering concepts
 - Fleet requirements

- Inputs**
- Demolition costs
 - Equipment costs
 - Labour costs
 - Support costs
 - Engineering data
 - Activity data

- Inputs**
- Cost estimate data
 - Execution alternatives
 - Quantity schedules
 - Accounting standards
 - Multi options and criteria

Engineering and Environmental Context

Cost Estimation

Cost Analysis and Reporting

- Outputs**
- Volumes
 - Areas
 - Material specifications
 - Haulage distances

- Outputs**
- Cost estimate data
 - Equipment hours
 - Quantity schedules
 - Unit costs
 - Productivities

- Outputs**
- Summary tables
 - Cash flows
 - Cost Summaries
 - Options estimates
 - Multi criteria analysis
 - Cost benefit analysis

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Cost Estimating Process – Environmental and Engineering Context

Input from subject matter experts

- Closure planning
- Geotechnical/mine engineering
- Tailings engineering
- Environmental science
- Social and legal responsibility
- Operations teams

Engineering and Environmental Guidance

- Closure vision and goals
- Conditions and commitments
- Stakeholder expectations
- Site characteristics
- Basis of design
- Design specifications
- Benchmarking site data

Cost Estimating Process – Cost Estimation

Provides governance for estimating costs

- Estimating standards, internal/external
- Bottom up and first principles cost data
- Execution strategy, owner or third-party contractor
- Infrastructure demolition requirements
- Activity and task-based data

Cost estimating tools

- Excel spreadsheets, SRCE, company calculators
- IFRS financial reporting compliance
- Regulator acceptance

Cost Estimating Process – Cost Analysis and Reporting

Provides for reporting and analysis of estimated costs

- Unit cost analysis and benchmarking
- Cash flow analysis and scheduling
- Summary reporting tables
- Cost estimate outputs
 - Unit rate compilation and calibration
 - Rehab materials quantity schedules
 - Domain and feature activity reporting
 - WBS and project management input
 - Multi criteria and cost benefit analysis
 - Decision making input and analysis

THANK YOU

CLOSURE LEGACY
WHAT ARE YOU PREPARED
TO WALK PAST?

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