Clash of the Titans – Father Time, Mother Nature and the Mine Waste Cover

Maritz Rykaart, PhD, PEng, SRK Consulting (Canada) Inc.

2017 SME Annual Conference & Expo, CMA 119th National Western Mining Conference, Denver, USA, February 20-22, 2017

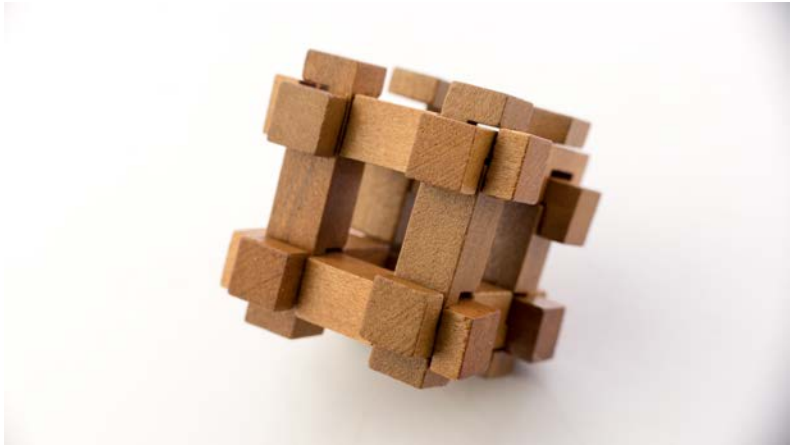
What this Talk is About

- Are closure covers a viable closure strategy?
- Why do closure covers continue to “fail”
- What are we doing about it?
- What should we be doing about it?

Confidential Site, USA

srk consulting

The Cover Engineer’s Conundrum



- General consensus
  - Closure mitigation is needed
  - Closure measures must stand up to Mother Nature and Father Time
- No consensus
  - How much of Mother nature to withstand
  - How long are we responsible to Father time

What is a Mine Waste Cover

Common Cover Myths

- Closure design = cover design
- Cover = no more AMD/metal leaching
- Cover design = geotechnical design
- Cover design = numerical modeling
- Cover design = instrumented field trials
- Cover performance = exact and measurable
- Covers last forever

Why Mine Waste Closure Covers

- Need definitive site specific answer to this question
- Disconnect remain between **site closure goals** and reason for using covers
- Should define separate terms
  - Closure **OBJECTIVES**
  - Cover **FUNCTIONS**

Johannesburg, South Africa

Defining Closure Objectives

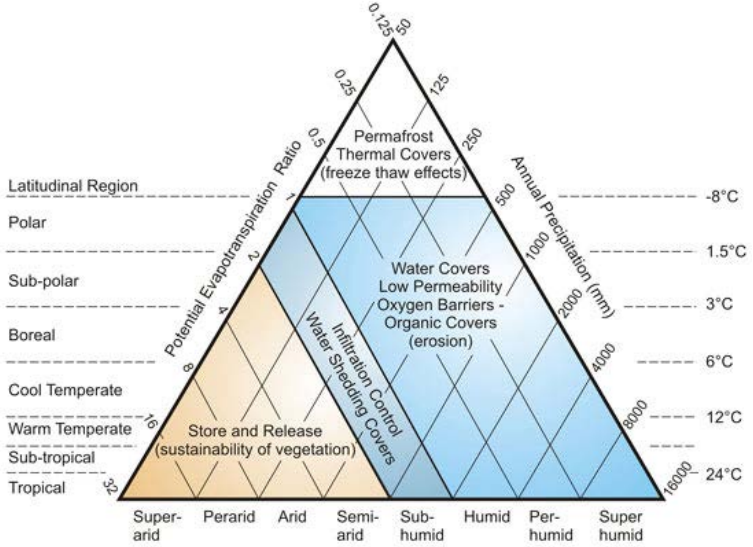
- Closure **Objectives** = fundamental reason/ motivation for doing closure work
- Typical reasons include
  - Remove health & safety risks
  - Prevent/remove/minimize environmental impacts
  - Reclaim social/economic land value
  - Regulatory compliance
  - Release bonds

Wismut, Germany

srk consulting

Defining Cover Function

- A cover is one **Tool** that can be used to achieve a Closure Objective
- Cover **Function** is the “work” that the cover must perform to achieve the Closure Objective
- Typical cover functions include
  - Radiation control
  - Waste stabilization
  - Seepage/leachate management
  - Physical stabilization
  - Thermal control
  - Promote vegetation



GARD Guide (INAP 2014)

srk consulting

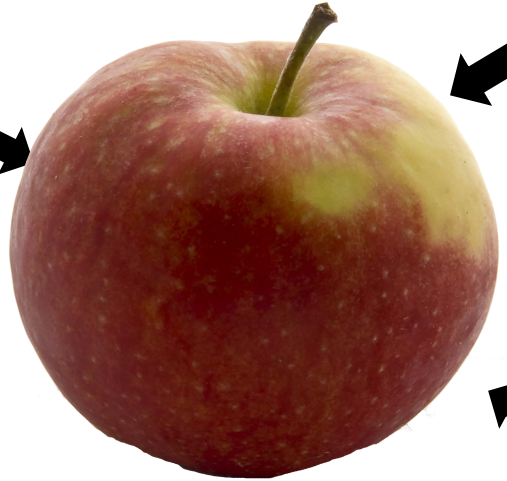
Conditions Imposed on Covers

Chemical Processes

- Osmotic Consolidation
- Dispersion/Erosion
- Dissolution/Precipitation
- Acidic Hydrolysis
- Mineralogical Consolidation
- Sorption
- Salinization
- Oxidation

Physical Processes

- Erosion
- Slope Instability
- Wet/Dry Cycles
- Freeze/Thaw Cycles
- Consolidation/Settlement
- Extreme Climate Events
- Brush Fires
- Construction



Biological Processes

- Root Penetration
- Burrowing Animals
- Bioturbation
- Human Intervention
- Bacteriological Clogging
- Vegetation Establishment

Covers are “Failing”

Confidential Site, USA

Confidential Site, USA

Engineering/Design Failures

srk consulting

Covers are “Failing”

Colomac Mine, Canada

Patterned Ground, Canada

State of Practice Limitations

srk consulting

Covers are “Failing”

Union Bay, Canada

Union Bay, Canada

Unreasonable Expectations

srk consulting

Covers are “Failing”

Confidential Site, Europe

Confidential Site, Canada

Mother Nature is in Charge

srk consulting

Mother Nature

Expect to see more emergencies like Oroville Dam in a hotter world

Roads closed, tourists stranded as record-breaking rains flood Pilbara region of WA

Massive Winter Weather System Brings 'Epic' Snowfall to Sierra Nevada

Monster storm breaks rain records at several Southern California locations

First Week of 2017: Record Cold, 48 States Going Below Freezing

Qld, NSW outback towns to reach high 40s as heatwave sweeps across eastern Australia

India crippled by extreme weather as 100 million exposed to floods

Covers will “Fail”…in the future

Bryce Canyon National Park, USA

Pyramid of Khafre, Egypt

Father Time outlasts all…

srk consulting

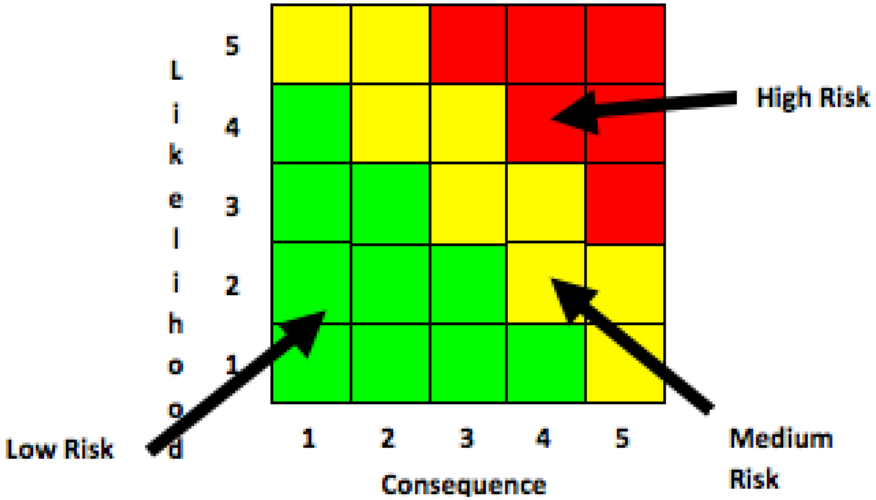
Father Time

Oldest Man-Made Structure:
Theopetra Cave, Stone Wall,
Greece, 21000 BC

All of these has undergone extensive remedial work and require ongoing maintenance

How are we mitigating these challenges

- Learn from our failures
- Develop Best Practice guidelines
- Make risk based decisions
- Apply best available technology to manage uncertainty such as climate change
- Demand “walk-away” closure
- Design for “indefinite” timelines



How are we mitigating these challenges

- Learn from our failures
- Develop Best Practice guidelines
- Make risk based decisions
- Apply best available technology to manage uncertainty such as climate change
- Demand “walk-away” closure
- Design for “indefinite” timelines

There is only one thing more painful than learning from experience, and that is not learning from experience. ***Laurence J. Peter***

srk consulting

Best Practice Guideline Documents

DESIGN, CONSTRUCTION AND PERFORMANCE MONITORING OF COVER SYSTEMS FOR WASTE ROCK AND TAILINGS

VOLUME 1 – SUMMARY

MEND 2.21.4a

DESIGN, CONSTRUCTION AND PERFORMANCE MONITORING OF COVER SYSTEMS FOR WASTE ROCK AND TAILINGS

VOLUME 2 – THEORY AND BACKGROUND

MEND 2.21.4b

DESIGN, CONSTRUCTION AND PERFORMANCE MONITORING OF COVER SYSTEMS FOR WASTE ROCK AND TAILINGS

VOLUME 3 – SITE CHARACTERIZATION AND NUMERICAL ANALYSES OF COVER PERFORMANCE

MEND 2.21.4c

DESIGN, CONSTRUCTION AND PERFORMANCE MONITORING OF COVER SYSTEMS FOR WASTE ROCK AND TAILINGS

VOLUME 4 – FIELD PERFORMANCE MONITORING AND SUSTAINABLE PERFORMANCE OF COVER SYSTEMS

MEND 2.21.4d

DESIGN, CONSTRUCTION AND PERFORMANCE MONITORING OF COVER SYSTEMS FOR WASTE ROCK AND TAILINGS

VOLUME 5 – CASE STUDIES

MEND 2.21.4e

Macro-Scale Cover Design and Performance Monitoring Manual

MEND Report 2.21.5

Modelling the Critical Interactions between Cover Systems and Vegetation

MEND Report 2.21.6

Mine Waste Covers in Cold Regions

MEND Report 1.61.5a

Cold Regions Cover Research – Phase 2

MEND Report 1.61.5b

Cold Regions Cover System Design Technical Guidance Document

MEND Report 1.61.5c

srk consulting

Prescriptive Guidance Documents

srk consulting

What should we be doing

- Recognize we cant outwit Mother Nature and Father time
  - Design with finite timeline in mind
- Work towards a paradigm shift
  - Put measures in place to manage the future
- Really do what we say
  - “Design for closure”

2011 Japan Tsunami

srk consulting

Conclusion

- Covers remain appropriate closure tool
- Be realistic and explicit about expectations
- Be cautious of prescriptive designs
- Think proactive not reactive
  - Cover practitioners should work towards putting themselves out of a job!

Machu Picchu, Peru