Projects and Management Systems of Tailings Dams: A Global Outlook

17th Brazilian Mining Congress

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University of British Columbia

Mount Polley Tailings Failure August 4, 2014


Mount Polley
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retention
basin
Quesnel
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Hazeltine Creek
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1 km


Mount Polley
Mine
Polley
Lake
Hazeltine Creek
Quesnel
Lake
N
1 km

Mount Polley Tailings Storage Facility Breach on August 4, 2014

Independent Expert Engineering Investigation and Review Panel

Report on Mount Polley Tailings Storage Facility Breach

January 30, 2015

Independent Expert Engineering Investigation and Review Panel

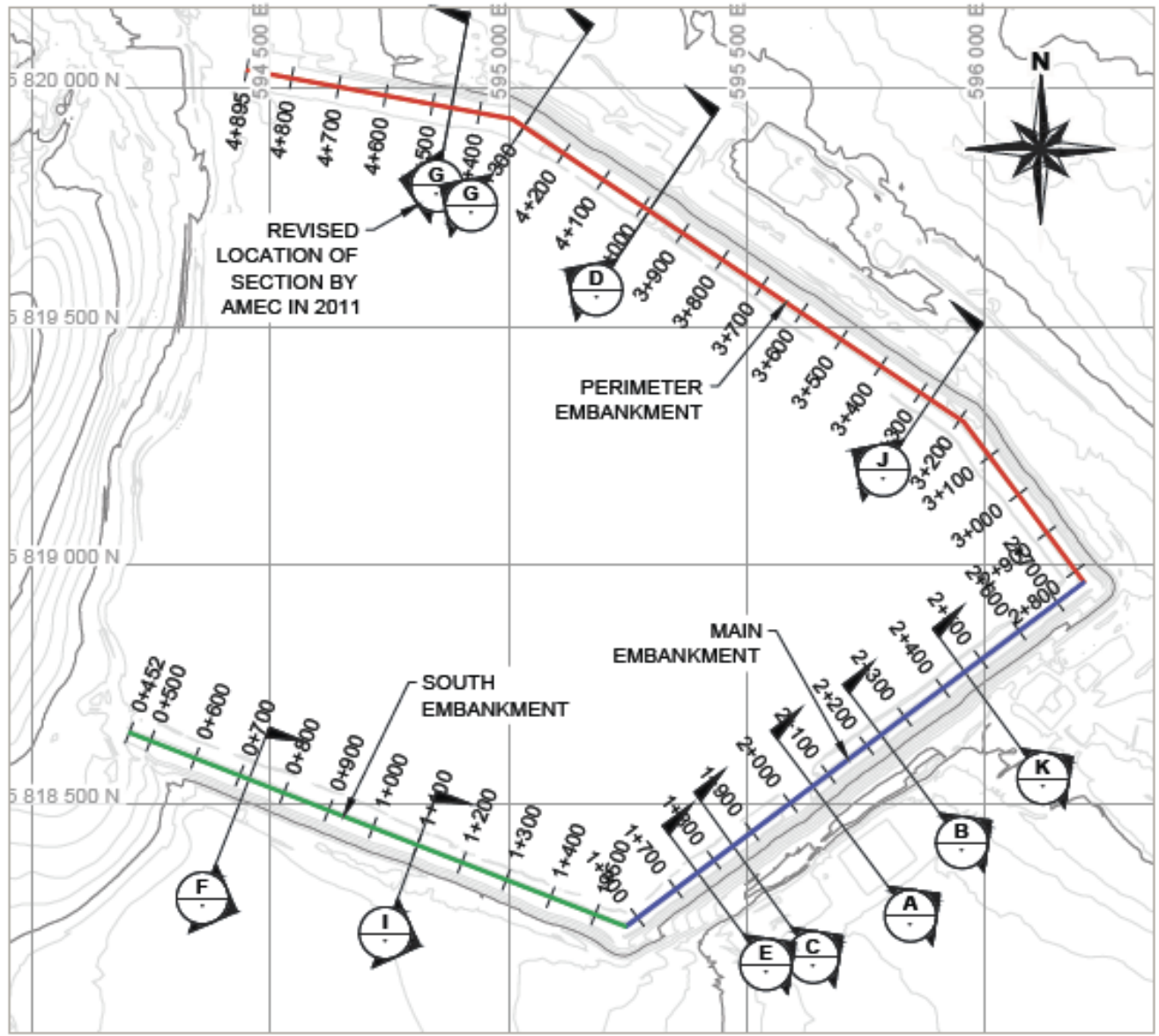
Report on Mount Polley
Tailings Storage Facility Breach

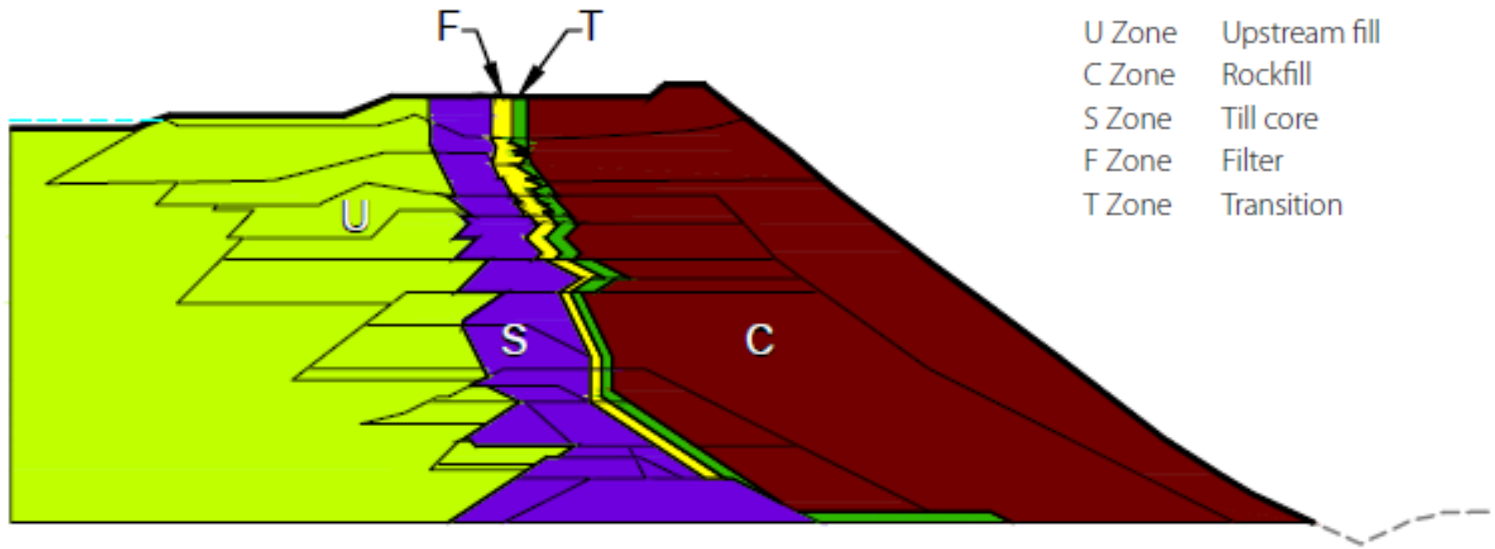
APPENDICES A – I

January 30, 2015

https://www.mountpolleyreviewpanel.ca

FIGURE 3.1.1: TAILINGS STORAGE FACILITY PLAN





U Zone	Upstream fill
C Zone	Rockfill
S Zone	Till core
F Zone	Filter
T Zone	Transition

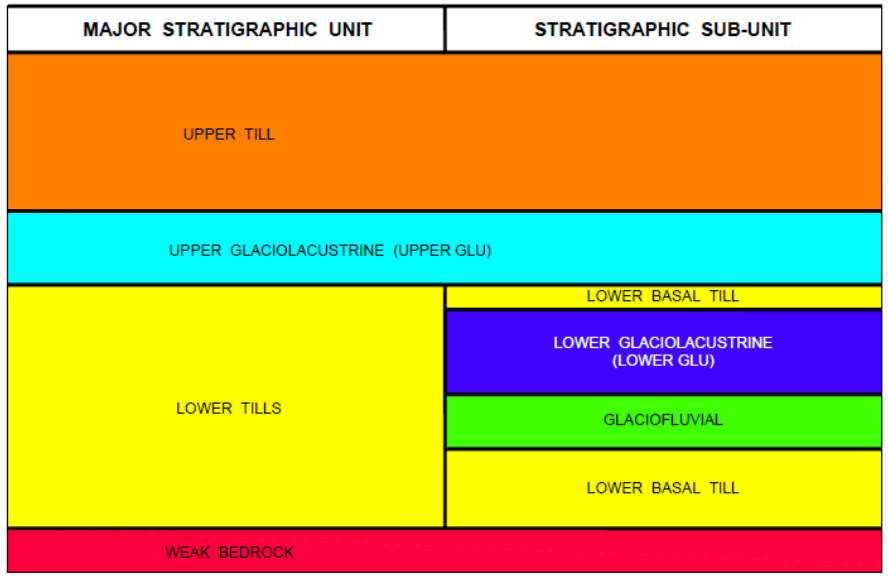
FIGURE 5.1.5: APPARENT BEDDING ROTATION ON LEFT ABUTMENT OF BREACH (SEPT. 4, 2014 PHOTO)

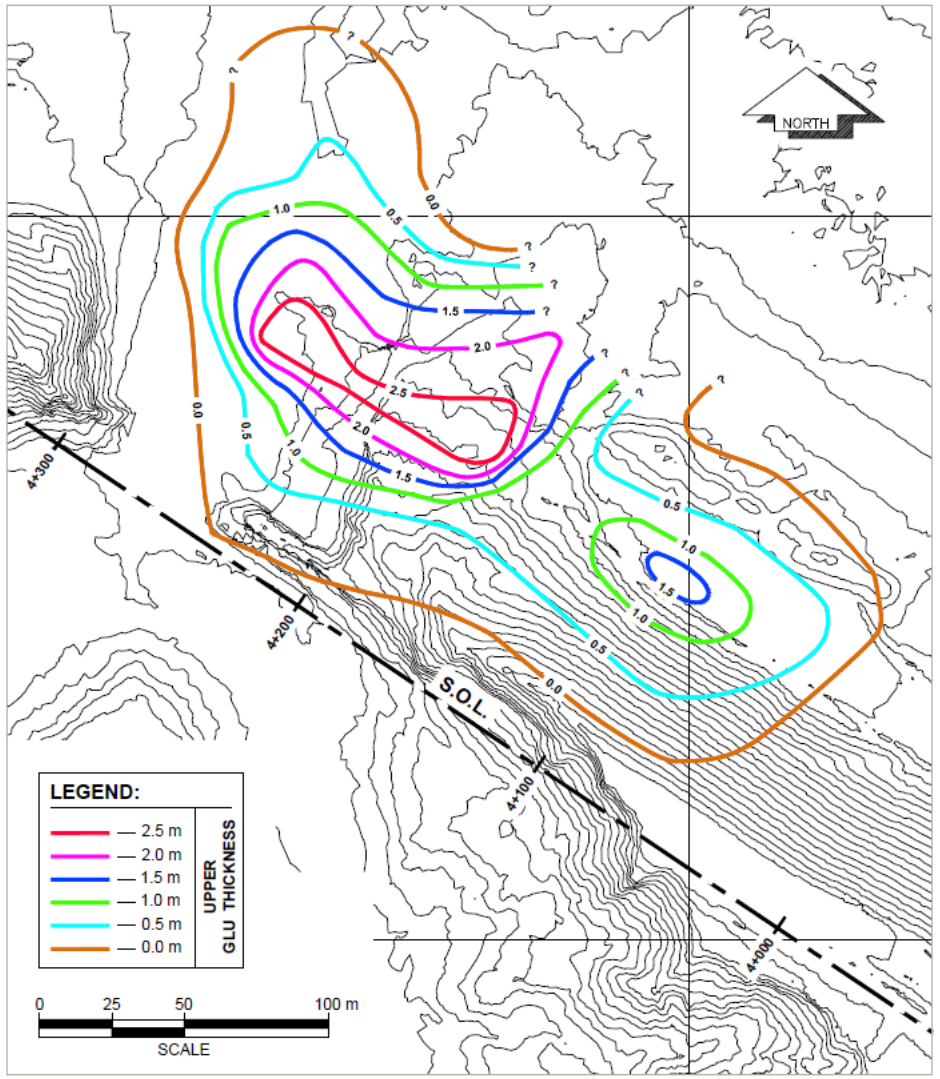
FIGURE 5.1.6: SLIDING-RELATED FEATURES AT RIGHT ABUTMENT (SEPT. 4, 2014 PHOTO)

TABLE 5.1.1: MEASURED AND INFERRED SLIDE MOVEMENTS

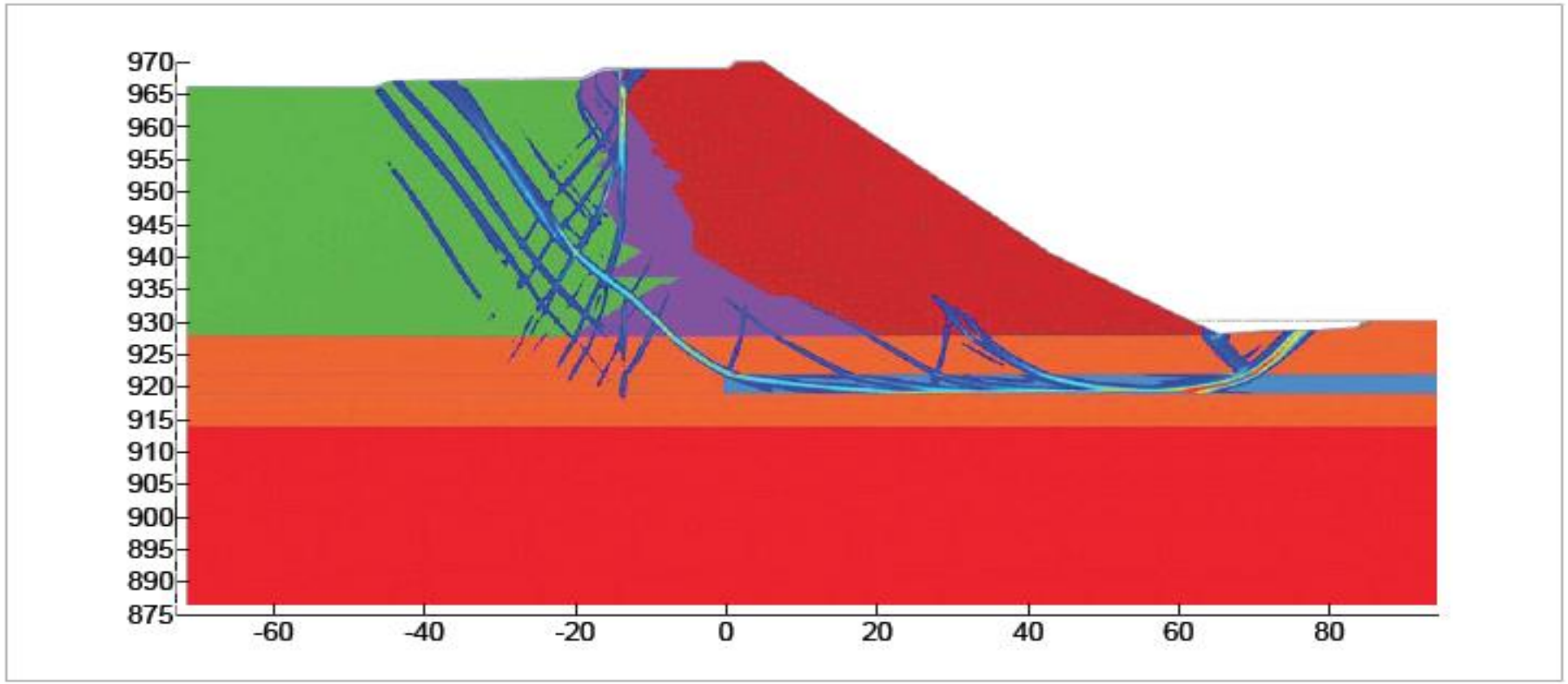
LOCATION	DISPLACEMENTS AND ORIENTATIONS	
DOWNSTREAM TOE	Vertical: Horizontal:	2.8 to 3.5 m upward 11 m downstream
UPSTREAM SHEAR SURFACE	Vertical: Dip:	>3.3 m downward 47 degrees
RIGHT ABUTMENT	Rotation:	5 to 14 degrees
LEFT ABUTMENT	Rotation:	7 to 10 degrees

FIGURE 5.2.3: GENERALIZED SOIL STRATIGRAPHY IN BREACH AREA

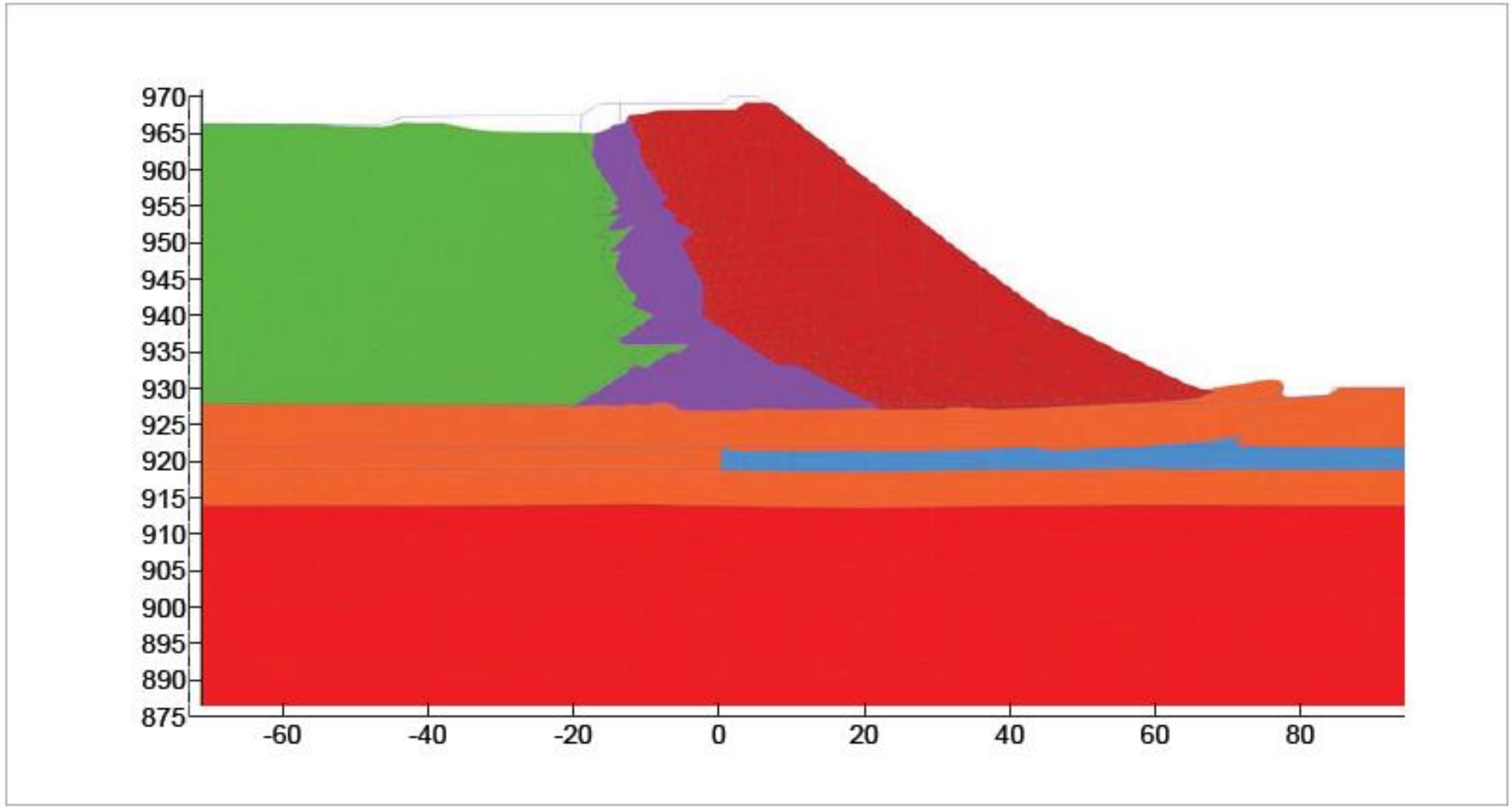




Contours of Upper GLU Thickness



Modeled failure surface matched failure surface location agreed with field observations.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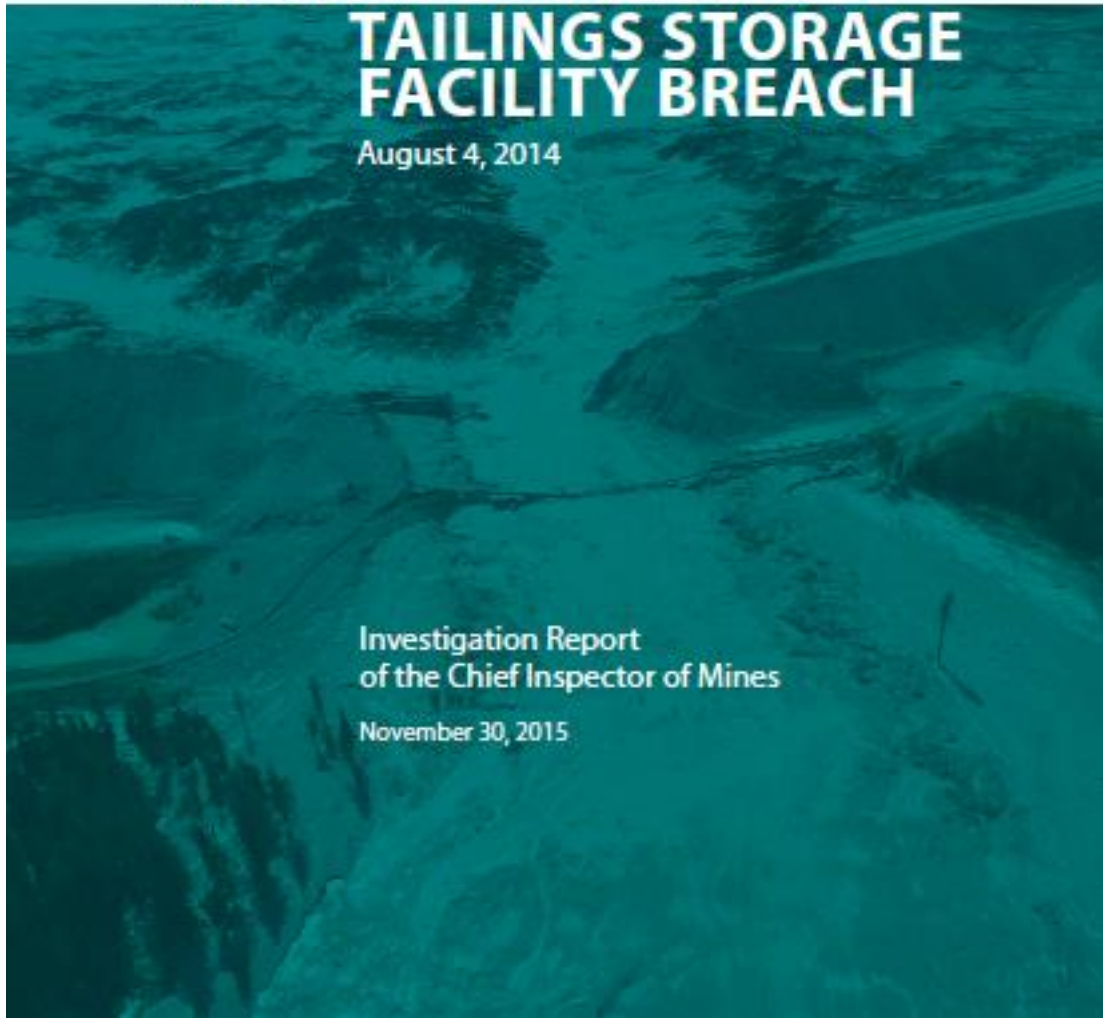
BRITISH COLUMBIA

Mining and Mineral Resources Division
Ministry of Energy and Mines

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY BREACH

August 4, 2014

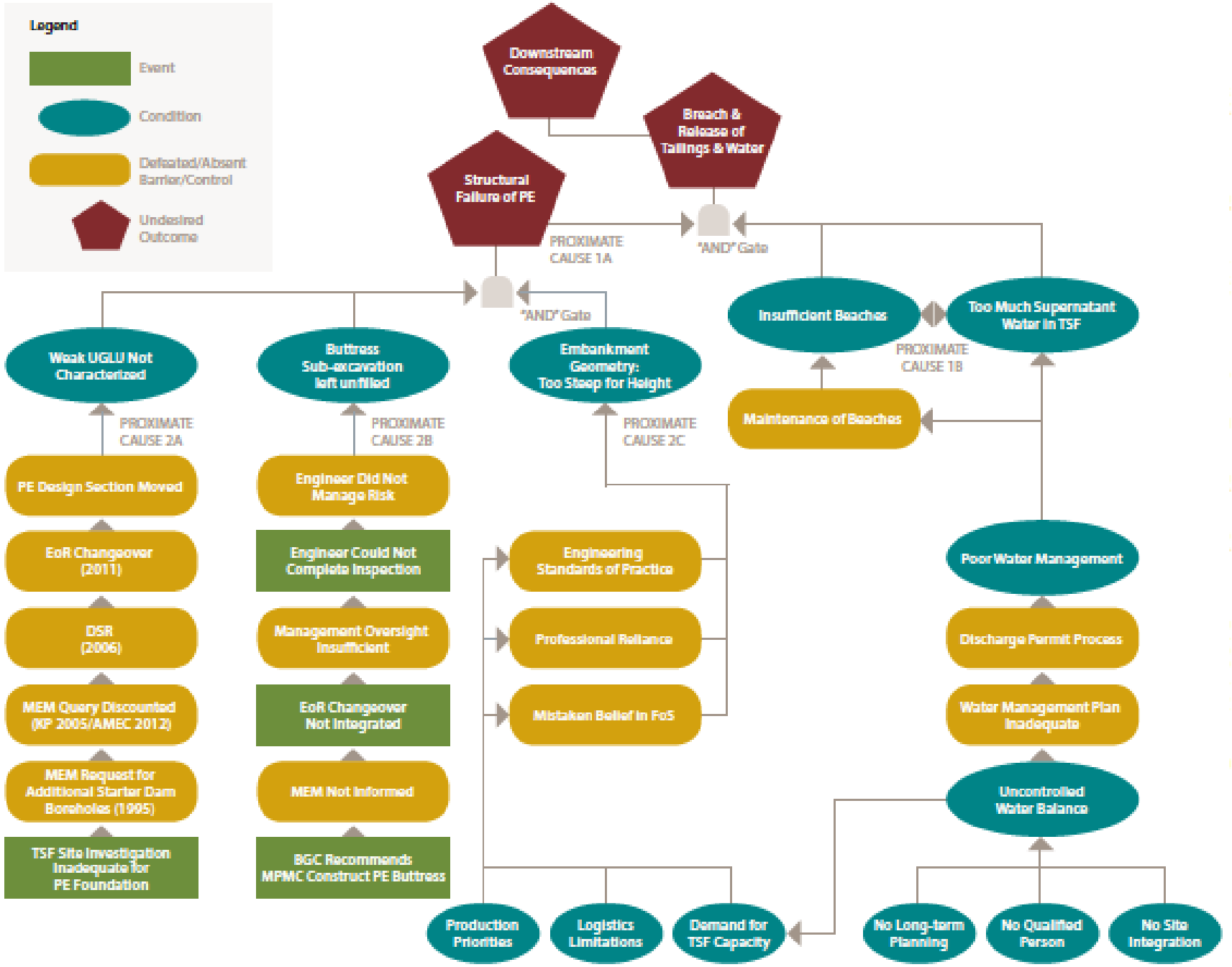


Investigation Report of the Chief Inspector of Mines

November 30, 2015

Outcomes

- Agreed with Panel failure mode
- Slightly different failure sequence
- Spent much more time understanding the company governance and motivations
- Excellent report



Root Cause Analysis Event and Causal Factor Tree

New Directions

Canada

Report of the TSM Tailings Review Task Force

Recommendations to Strengthen the Mining Association of Canada's Tailings Management Requirements and Guidance

November 18, 2015

A Guide to the

Management of Tailings Facilities

THIRD EDITION

The Mining Association of Canada

TSM ASSESSMENT PROTOCOL

A Tool for Assessing Tailings Management Performance

Purpose

The purpose of the assessment protocol is to provide guidance to facilities in completing their evaluation of tailings management performance against TSM indicators. The assessment protocol sets out the general expectations for tailings management as part of the TSM initiative.

As with any assessment of a management system, professional judgment is required in assessing the degree of implementation of a system indicator and the quality of management processes and intervention. Application of this protocol will, therefore, require a level of expertise in auditing and systems assessment and knowledge of and experience in the practice of tailings management. This assessment protocol provides an indicator of the level of implementation of proactive tailings management practices as part of the TSM initiative. It is not, of itself, a guarantee of the effectiveness of tailings management activities.

Performance Indicators

Five performance indicators have been established.

1. Tailings management policy and commitment
2. Tailings management system
3. Assigned accountability and responsibility for tailings management
4. Annual tailings management review
5. Operation, maintenance and surveillance (OMS) manual

While this protocol focuses on the physical management of tailings facilities and internal accountability and review mechanisms, an additional critical component of good practice in tailings management is community engagement. TSM addresses tailings related community engagement as part of a broader topic on engagement regarding risks to communities and as such, tailings engagement requirements are contained in the TSM Aboriginal and Community Outreach Protocol. Specifically, Indicator 2 of the TSM Aboriginal and Community Outreach Protocol requires facilities to have processes in place to engage with COI on credible risks to the public that are associated with company activities, including tailings management. Specific topics for engagement should be determined through dialogue with COI.

Action Plans

Facilities that have not achieved a minimum of a Level A for the tailings management indicators are required to disclose in their company profile section of the annual *TSM Progress Report* actions that the company intends to take to achieve a Level A.

Tailings management action plans should address at a minimum:

- Identified gaps in indicators where the facility has not achieved a Level A
- Specific actions the company will take to reach a Level A
- Timeline for implementing actions (note: actions must be implemented within three years)

REVISIONS TO PART 10 EFFECTIVE AS OF JULY 20, 2016

SCHEDULE

1 Part 10 of the Health, Safety and Reclamation Code for Mines in British Columbia is repealed and the following is substituted:

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Definitions

"*best available technology*" means the site specific combination of technologies and techniques that most effectively reduce the physical, geochemical, ecological and social risks associated with tailings storage during all stages of operation and closure.

"*dam*" means a barrier on the surface preventing uncontrolled release of either water, slurry or solids or a barrier underground to prevent the uncontrolled flow of water, slurry or solids.

"*dump or stockpile*" means the accumulation of deposited rock fragments or other unconsolidated material

"*engineer of record*" means the Professional Engineer who is retained under section 10.1.5 (1) of this code.

BRITISH COLUMBIA

Guidance Document

Health, Safety and Reclamation Code for Mines in British Columbia

Version 1.0

Updated July 2016

Professional Practice Guidelines - Site Characterization Assessments for Dam Foundations in BC

Professional Engineers and Geoscientists of BC

www.apeg.bc.ca

USA

http://leg.mt.gov/bills/mca_toc/82_4_3.htm

Montana Code Annotated 2015

Search · MCA Contents

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TITLE 82. MINERALS, OIL, AND GAS
CHAPTER 4. RECLAMATION

Part 3. Metal Mine Reclamation

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International

DECEMBER 2016

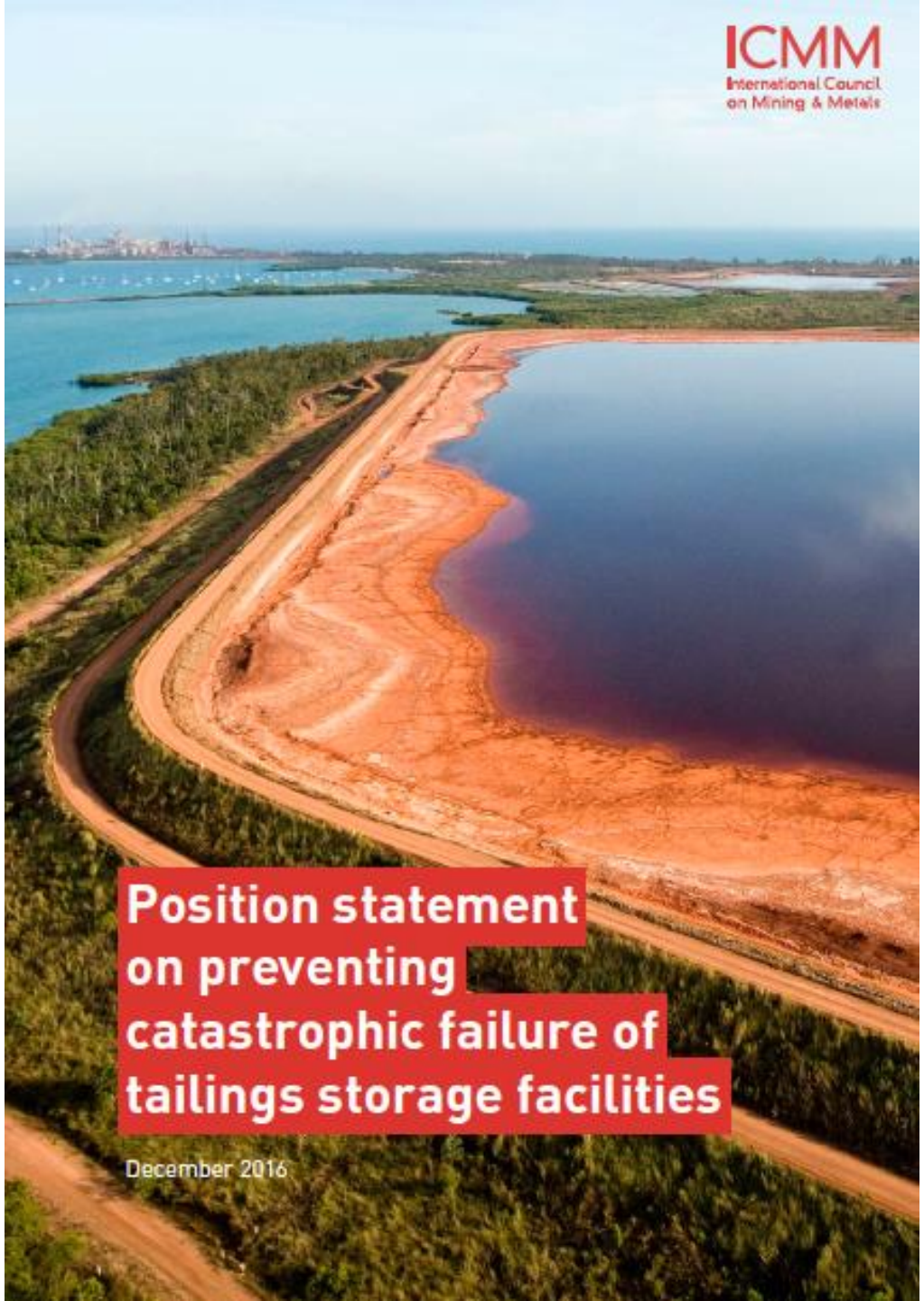
INTERNATIONAL COUNCIL ON MINING AND METALS (ICMM)

REVIEW OF TAILINGS MANAGEMENT GUIDELINES AND RECOMMENDATIONS FOR IMPROVEMENT

Submitted to:
International Council on Mining and Metals (ICMM)
35/28 Portman Square,
London W1H 6LR,
United Kingdom

REPORT

Golder Associates



UN environment
United Nations Environment Programme

VISION ZERO

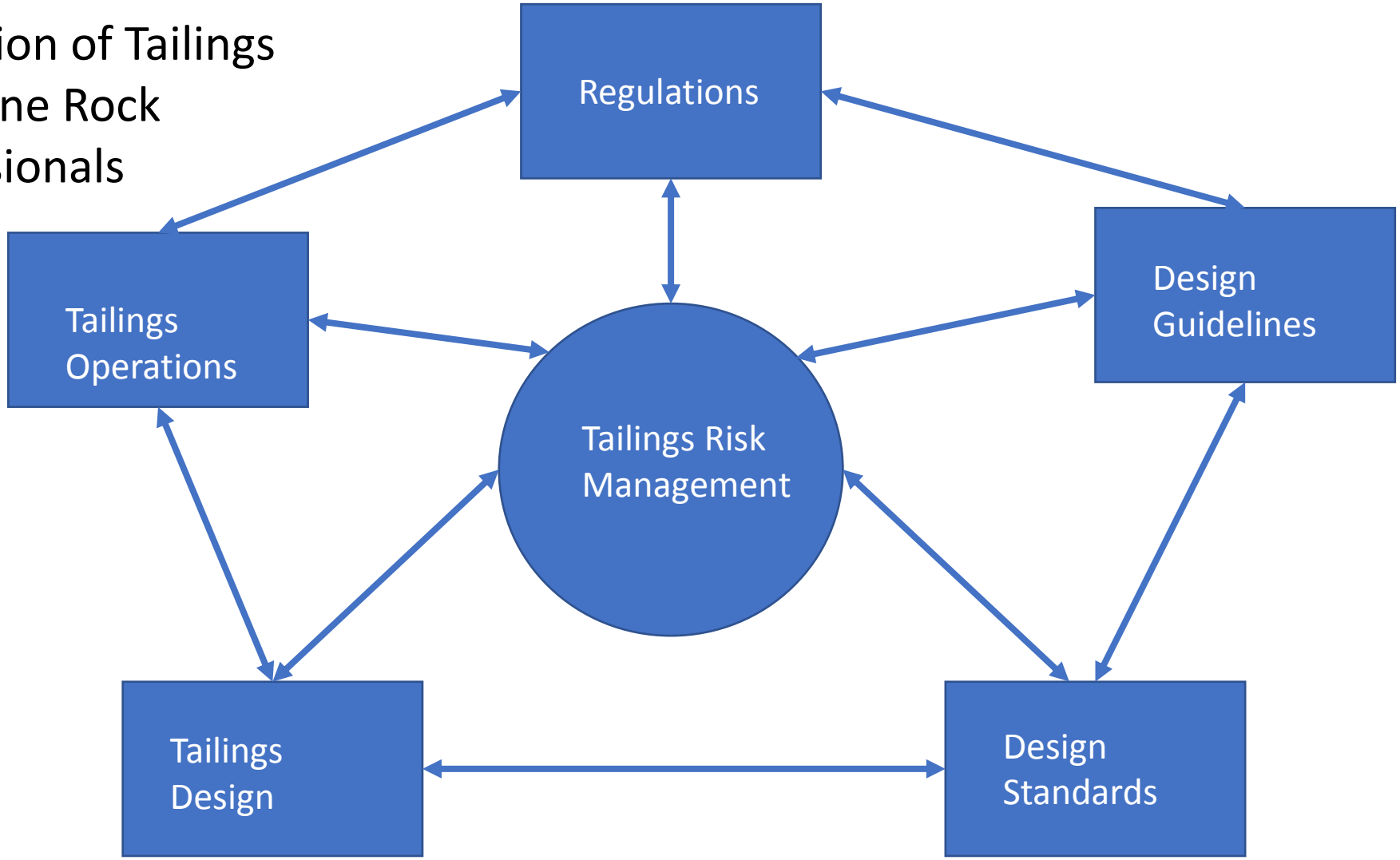
MINE TAILINGS STORAGE SAFETY IS NO ACCIDENT

A RAPID RESPONSE ASSESSMENT

Tailings Risk Management Infrastructure

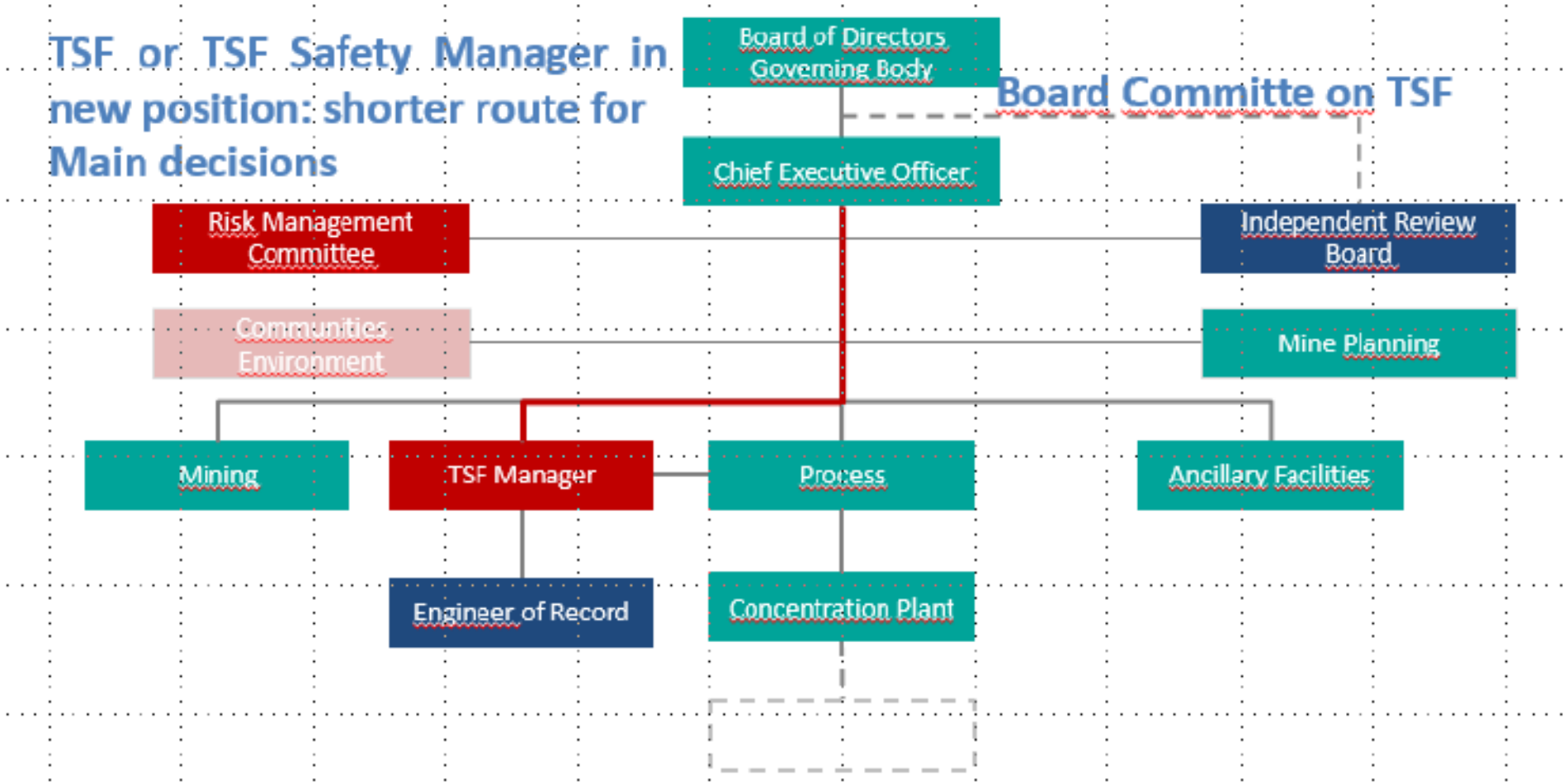
- Education and Training
- Regulations
- Design guidelines
- Design standards (compliance required and voluntary)
- Tailings design (typically by consultants)
- Tailings operations (mining company)

Education of Tailings and Mine Rock Professionals



A New Organizational Structure to Enhance Tailings Management?

New TSF position in the organization?



Valenzuela, Luis (2017) Tailings Dam Safety and Governance, Tailings 2017, Gecamin, Santiago

Significance of Robustness and Resilience

Robustness

- Robust Geotechnical Design (RGD) - A design is considered robust if the variation in system response (e.g. failure probability) is insensitive to the statistical characterization of noise factors, such as uncertain geotechnical parameters

Resilience

- Resilience is the intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions

Resilience Engineering and Management

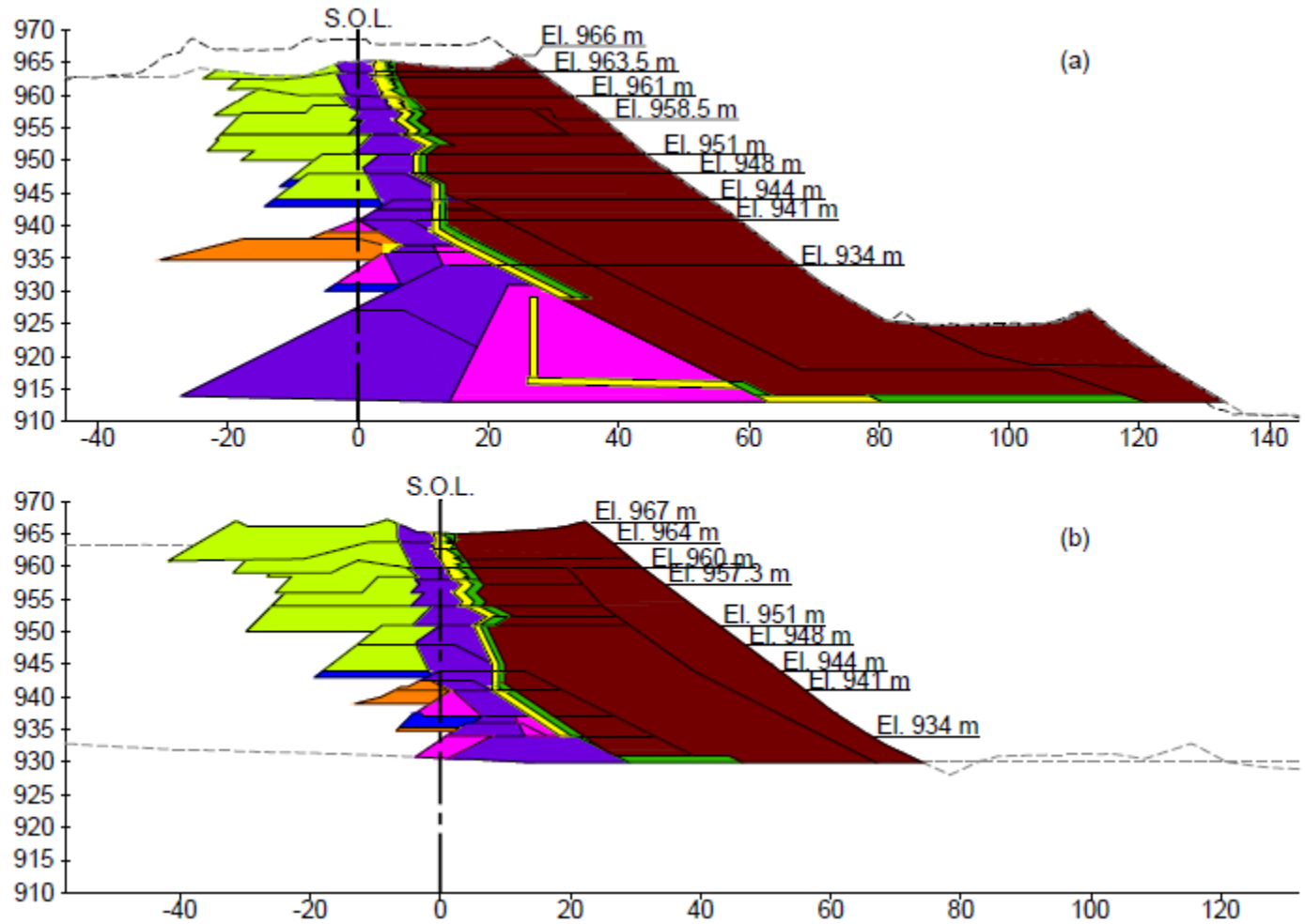
- Resilience engineering and management is based on the following four components:
  - **Monitoring** – knowing what to look for – timely measurement and analysis
  - **Performance prediction** – knowing what is expected – identifying when performance is not meeting expectations and critical control actions are triggered
  - **Implementing critical control actions** – knowing what to do – implementing in a timely manner
  - **Learning from performance** and critical control responses to improve the system model, assess residual risks and apply resilience engineering and management to increase robustness and post failure resilience.

Robustness and Resilience (2)

- Robustness and resilience changes over the life of a facility, e.g.
  - The exceedance of pre-consolidation pressure of glaciofluvial layer at Mount Polley
- The level of risk management must increase over the life of the tailings facility
- Critical controls must be re-evaluated all the time

Closing Comments

- The recent tailings failures have attracted much attention from tailings engineers, mining companies, regulators and the public worldwide
- Many changes are happening that impacts the design and operations of tailings management facilities and it is expected that this will continue for years
- Tailings governance is a critical issue and will receive significant attention from industry, regulators and communities
- We are in a time that will see ongoing changes in tailings design, operations and management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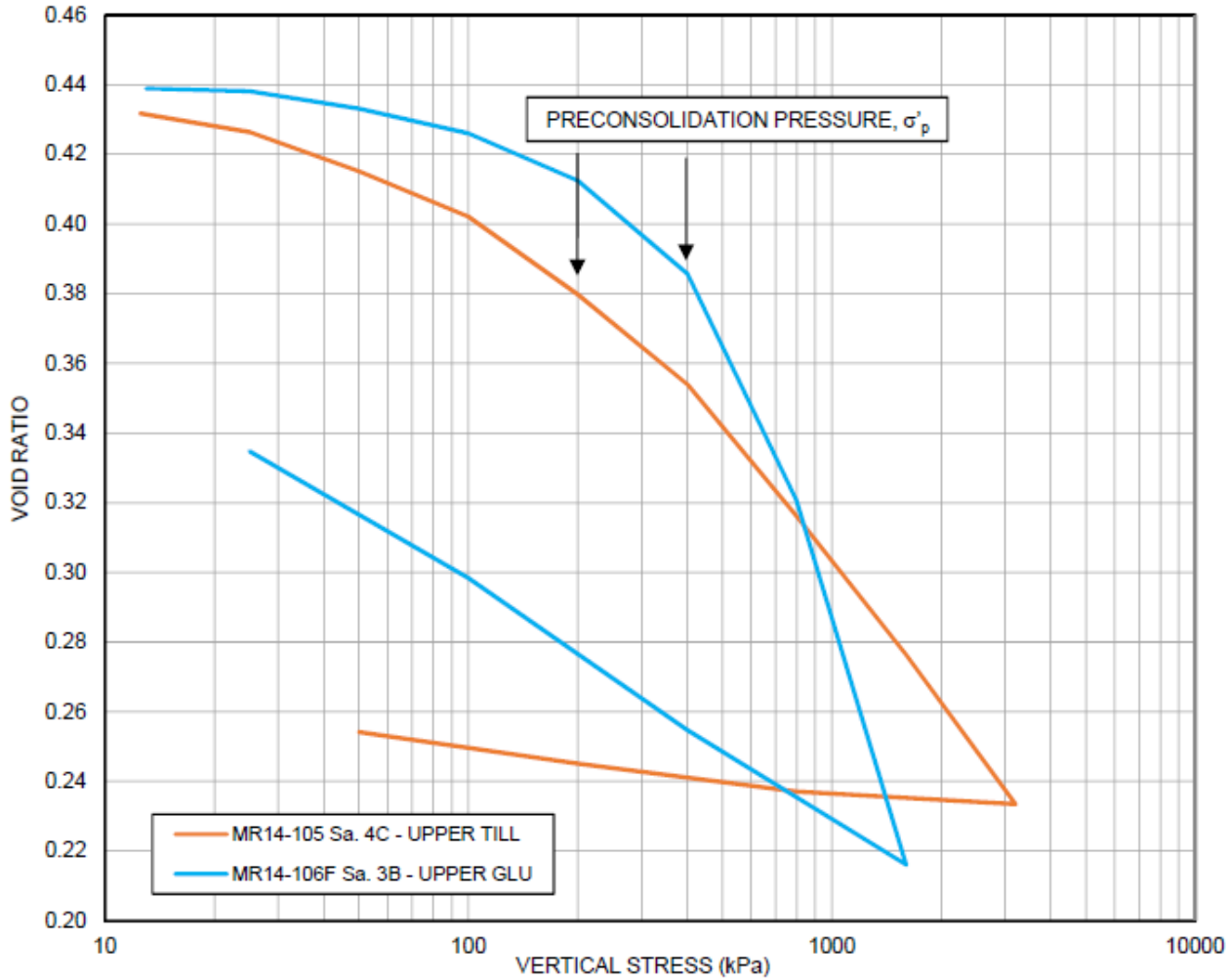
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MR14-106F Sa. 3B - UPPER GLU
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