

Engineer of Record (EoR)

Retooling the Basic & Resolute Principle for Tailings Dams

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**HALEY
ALDRICH**



A stage with red curtains and spotlights. The stage is set with a large red curtain that has a scalloped top edge. The curtain is held back by two large tassels on the sides. The stage floor is made of light-colored wood. There are five spotlights on the floor, casting a warm glow. The text "Setting the Stage..." is written in a white, cursive font across the center of the image.

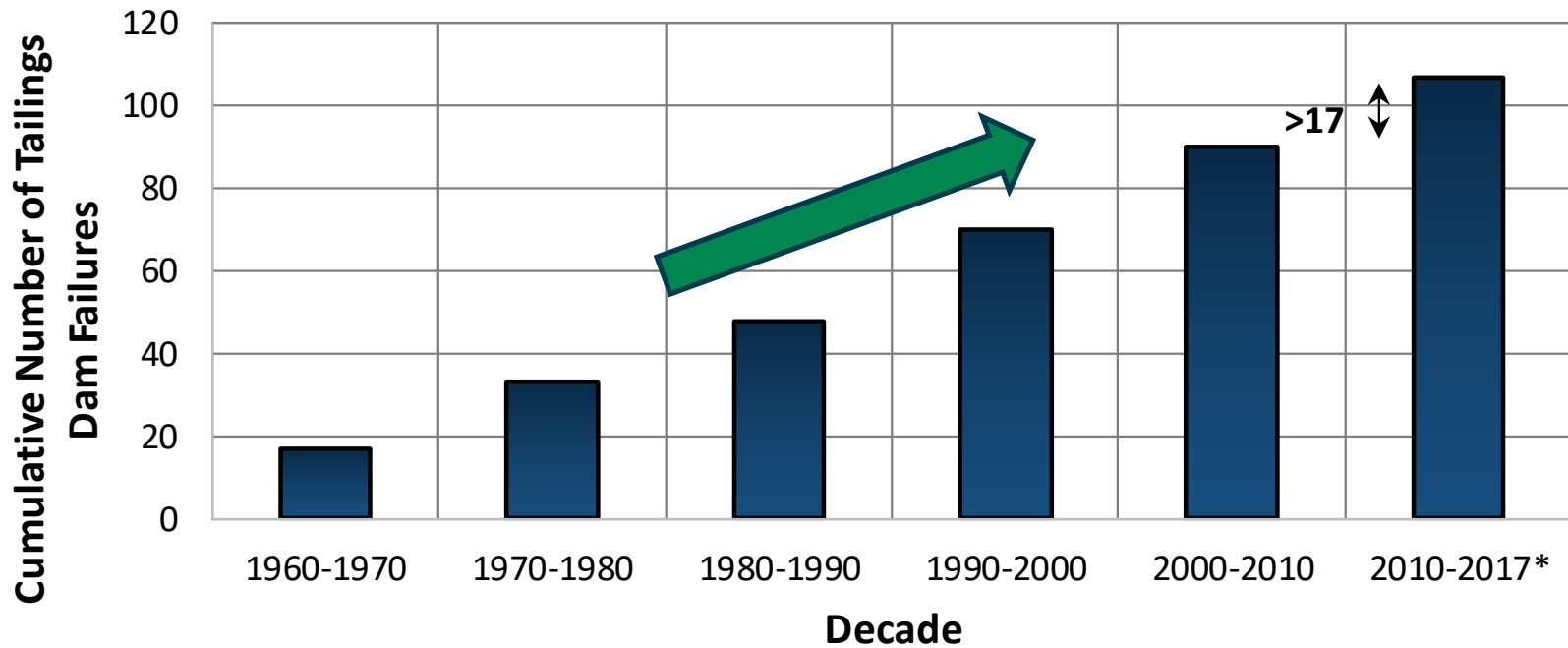
Setting the Stage...

Kahoot Survey

- Go to browser on phone (e.g., Safari) and enter **kahoot.com**
- Or, download the app:



Tailings Dam Failure History



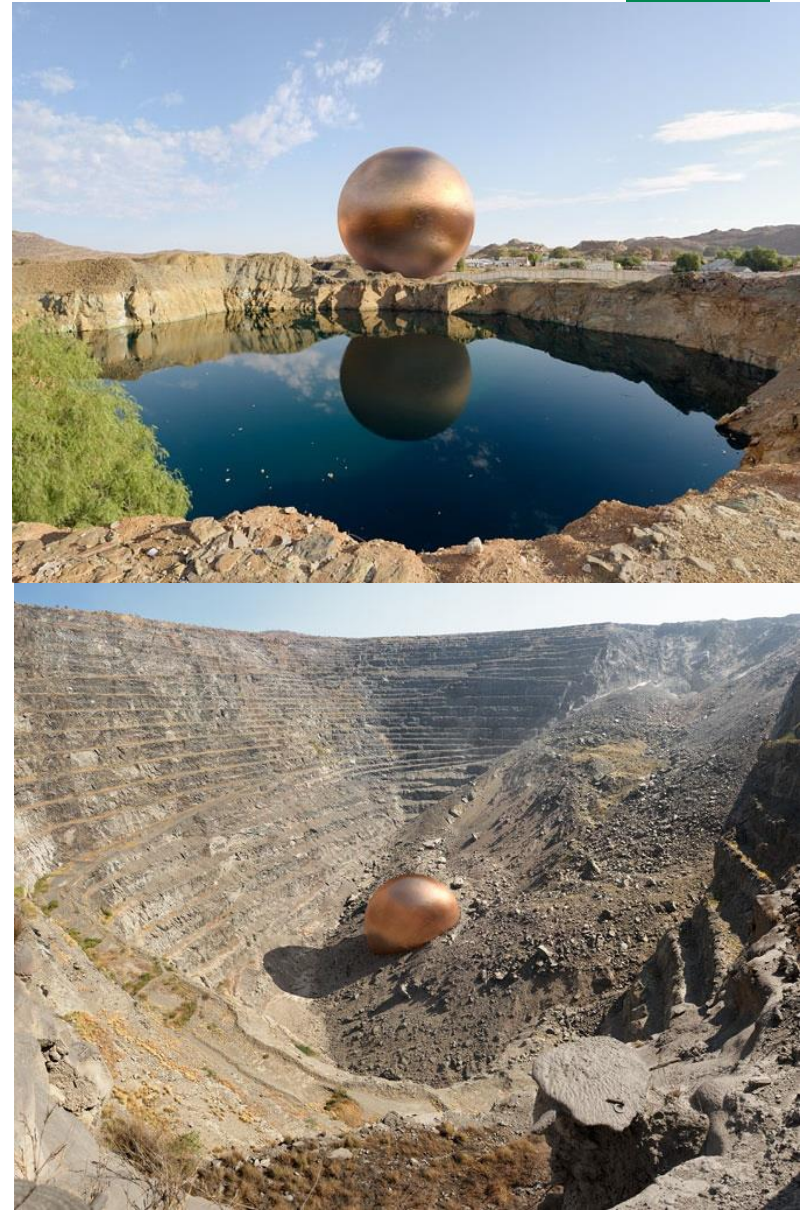
*Partial decade, with failures reported through June 2017.

Source: Trend in recorded instances of tailings dam failures as recorded on the WISE Uranium Project website (updated June 2017).

Tailings >> Product...

- Base metals – few % of ore = commodity
- Precious metals – few ounces per ton = commodity
- Oil sands – almost 100% of solids processed = tailings

*Photos: Dillon Marsh, Artist
(West O'okiep Copper Mine – top; Palabora Copper Mine – bottom)*

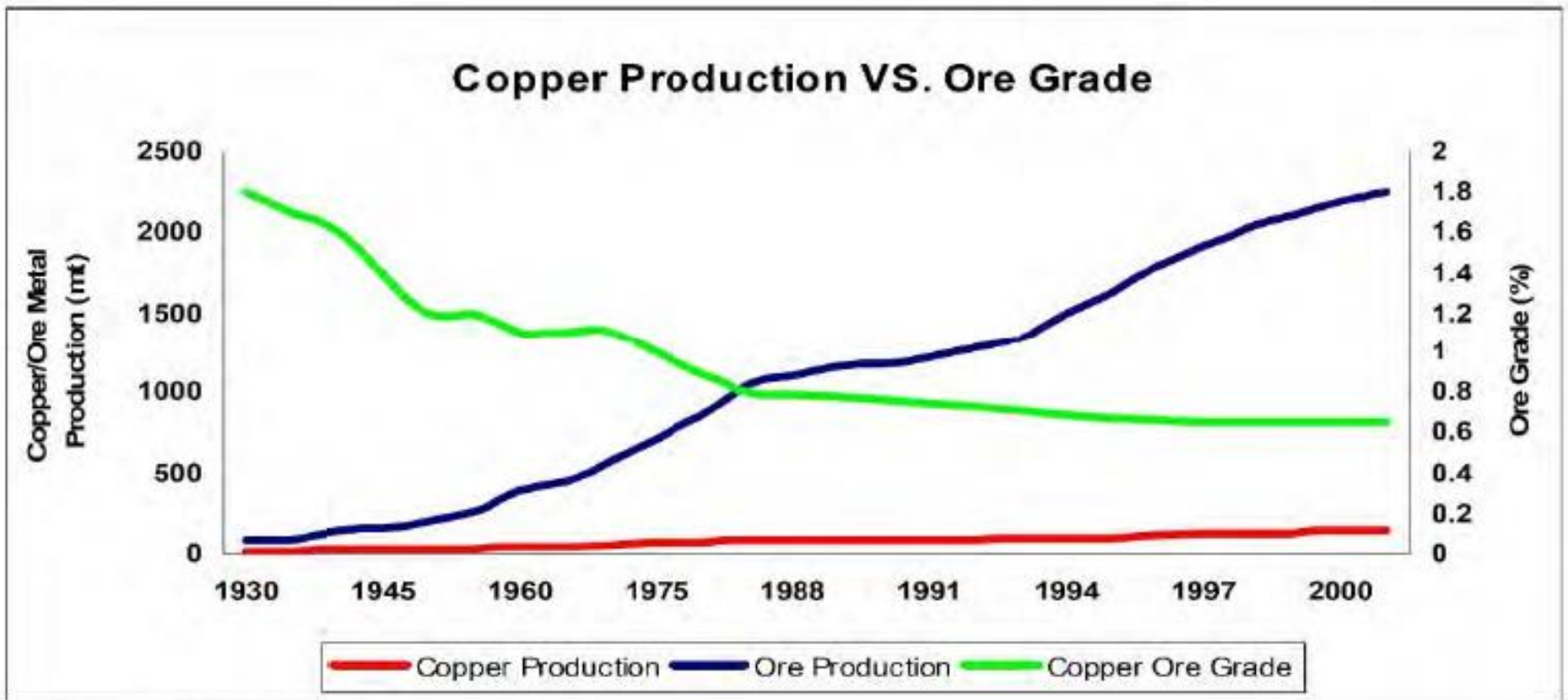


The modern “Mining Metric” is well mapped...

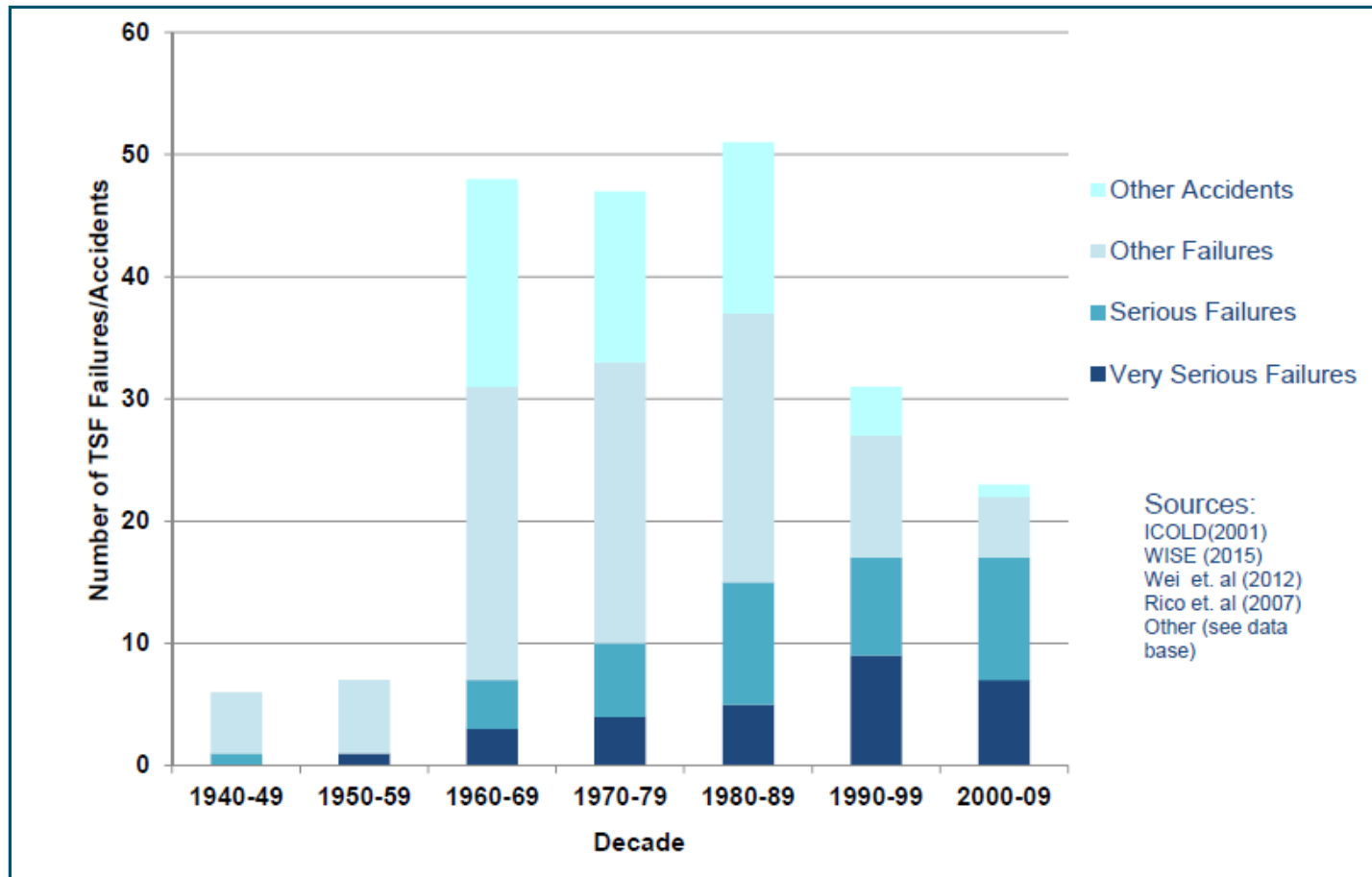
“Higher mine production necessitated by lower grades of ore, a century of declining prices offset by declining cost per ton. The metric is to continuously develop the resource through economies of scale, larger and deeper footprints, more efficient operations, bigger and better bulk mining technology.”

*Risk potential has increased by a factor of 20 every 1/3 century.
(Robertson 2011)*

Copper Production vs. Ore Grade



Increasing Severity of TSF Failures Globally (1940-2010)



Answering the Call...



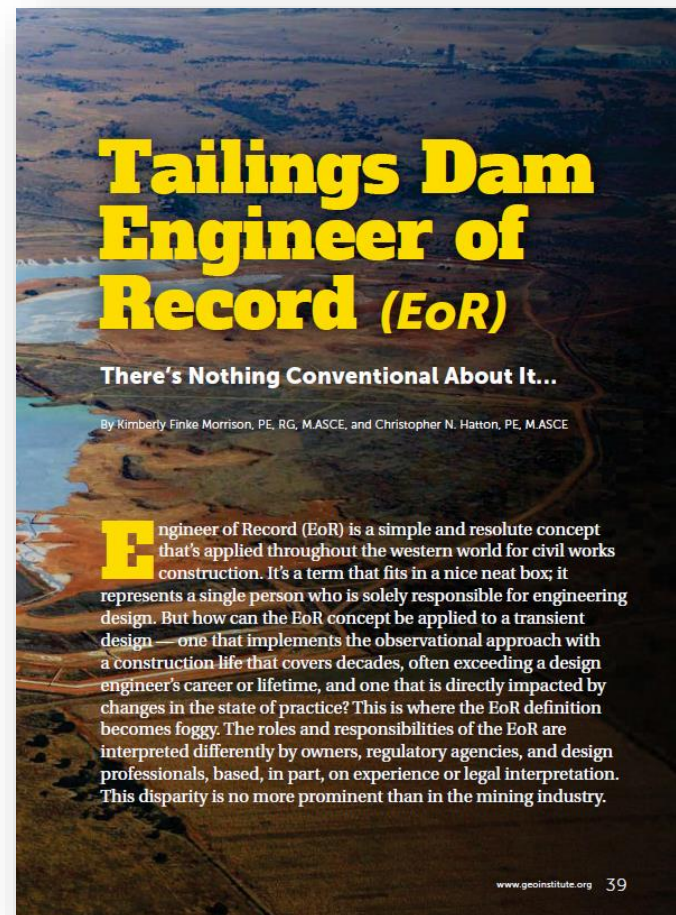
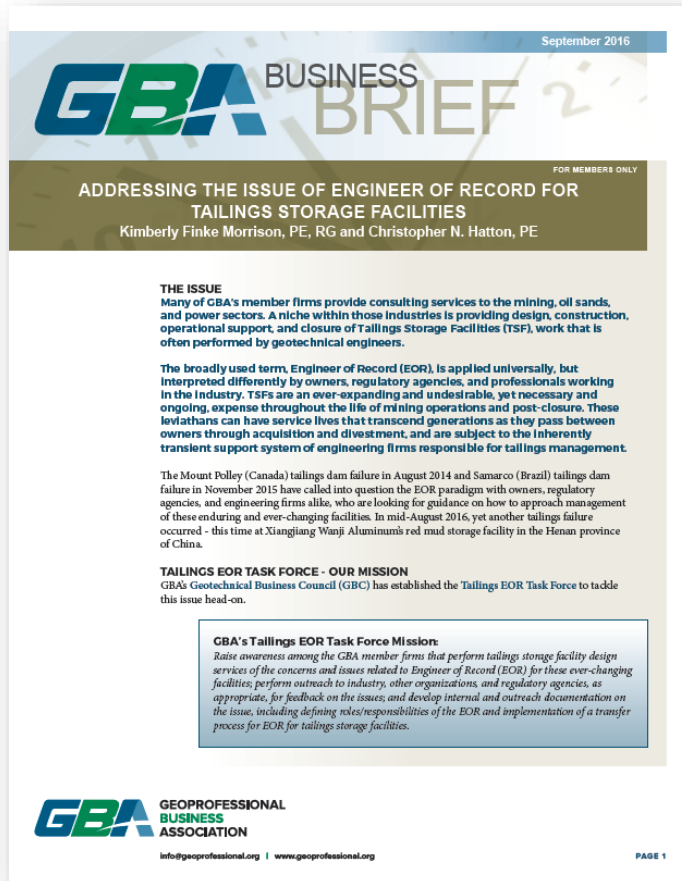
GBA's Tailings EoR Task Force

Our Mission:

Raise awareness among the GBA member firms that perform tailings storage facility design services of the concerns and issues related to Engineer of Record (EoR) for these ever-changing facilities.

- Our mandate:
 - Perform outreach to industry, other organizations, and regulatory agencies, as appropriate, for feedback
 - Develop guidance documentation defining roles/responsibilities of the EoR

Task Force in Action...



Tailings EoR Workshop

January 26, 2017 – Denver, CO



Event Sponsors:



Tailings EoR Workshop – Purpose

- Learn from each other through experience and case histories:
 - *One Size Does Not Fit All – EoR Legacy Design and Scalability*
 - *State and Federal Government EoR Positions & Initiatives*
 - *Engineer of Record – An Owner’s Perspective*
 - *EoR – Canadian Evolving Practice*
 - *USSD Tailings Committee Update*
 - *A Consultant’s Perspective on EoR Responsibilities*
 - *Overview of the Association of State Dam Safety Officials*
 - *Current Requirements for Tailings Dam Engineers in Alaska*
 - *Tailings Engineer of Record (EoR), Oil Sands Dam Safety Practice in Alberta Canada Regarding the EoR*
 - *GBA’s Tailings EoR Task Force Mission, Workshop Objectives & Insurer Concerns Pertaining to Tailings Work*

Tailings EoR Workshop – Purpose

- Learn from and obtain alignment with other organizations on the issues surrounding EoR for TSFs:



Tailings EoR Workshop – Purpose

- Review results of a detailed pre-workshop survey

A word cloud centered around the acronym 'eor' in large blue letters. The word 'responsibilities' is prominent in blue at the top left. 'operations' is in green below it. 'responsibility' is in red at the top right. 'owner' is in red to the right of 'operations'. 'designer record' is in red to the right of 'owner'. 'tsf' is in yellow to the right of 'eor'. 'required' is in green below 'tsf'. 'mining' is in black below 'required'. 'phase' is in green below 'mining'. 'engineer' is in purple below 'eor'. 'requirements' is in black below 'engineer'. 'separate' is in blue to the left of 'eor'. 'clear' is in red above 'separate'. 'identified' is in orange below 'separate'. 'other' is in blue below 'identified'. 'eors' is in green to the left of 'eor'. 'or' is in black above 'eor'. 'dor' is in black to the right of 'eor'. 'aspects' is in black above 'owner'.

responsibilities
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Tailings EoR Workshop – Purpose

- Participate in facilitated break-out sessions



Canadian Dam Association (CDA) Works to Address Issue

- CDA established a Mount Polley Task Group
 - Members of Dam Safety and Mining Dams Committees
 - Coordinate follow-up to the Mt Polley Panel Report
- Task Group made recommendations to CDA:
 - Regulatory roles and responsibilities
 - Improving tailings dam safety (BAPs, BATs)
 - Revisions to FS criteria
 - Assessment of consequences of dam failure
 - Improve definition of the EOR

BCMEM

Works to Address Issue

- Following the Mount Polley TSF breach and recommendations in the Panel Report
- British Columbia's Ministry of Energy and Mines (BCMEM)
 - Revised Health, Safety and Reclamation Code for Mines (i.e., Mining Code)
 - Contains new tailings management requirements
 - Released in July 2016
 - Several key legislated requirements for TSFs in BC

ICMM – TSF Position Statement

In December 2016, released position statement establishing ICMM's framework for the governance of TSFs:

1. Accountability, responsibility, and competency
2. Planning and resourcing
3. Risk management
4. Change management
5. Emergency preparedness and response
6. Review and assurance

US Agencies Position on EoR

- TSFs must comply with regulations and be permitted.
- State & federal programs that include EoR requirements, typically:
 - Design certification by a PE
 - Designation of EoR during construction
 - EoR or PE certification of construction and operation
 - Inspection (annual to 5-year) by a PE
- Programs generally include requirements for: design report, plans & specifications, OMS manual, EAP, inspections and reporting.
- EoR qualifications generally reference licensure as a PE (some cite experience in the type of dam and specific knowledge/experience for certain submittals)

US Agencies Positions on EoR

Organizations and agencies with initiatives on the EoR designation for TSFs:

- ASDSO Initiative: Tailings Dams Regulatory Committee; Survey of States with EoR requirements; Position on Engineering Certification
- Montana DEQ Program: EoR, third-party review and independent review panel qualifications, responsibilities, reporting, and succession
- Federal agency programs (MSHA, OSMRE, USEPA)



Montana DEQ Program

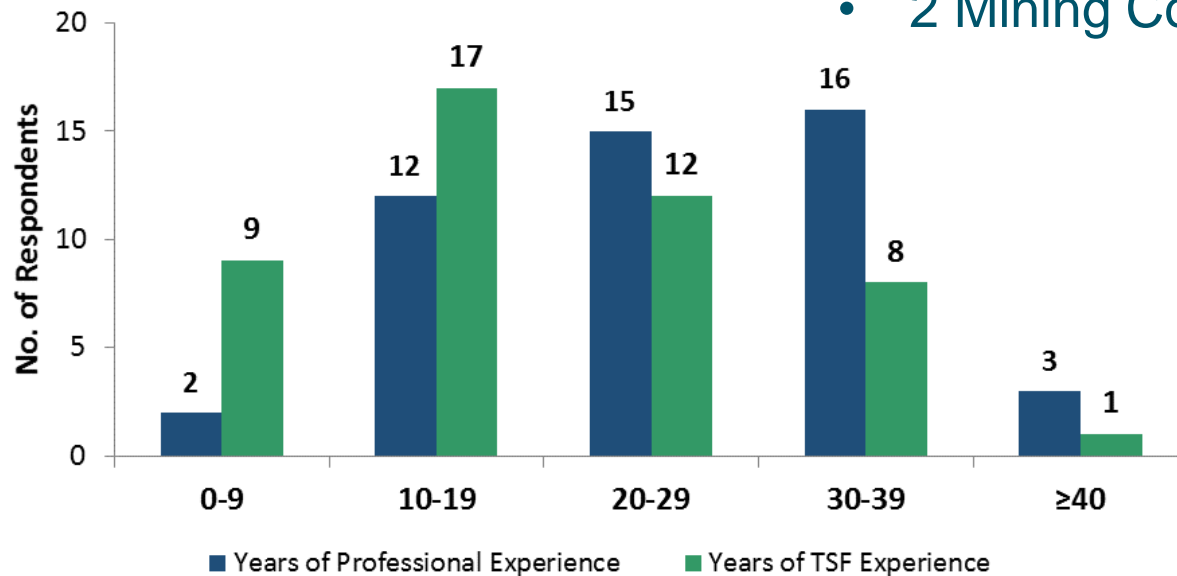
- Designation of EoR for existing facilities and new permits
- EoR may not be a mine employee or permit applicant
- TSF Independent Review Panel for design & operation
- EoR Duties:
 - Prepare, certify and seal designs and other submittals (OMS Manual, EPRP)
 - Address recommendations of the Independent Review Panel
 - Complete annual inspection and reports
 - Notify operator when credible evidence indicates the TSF is not performing as intended, and DEQ if the TSF presents an imminent threat to human health or the environment

Pre-Workshop Survey – Demographics & Experience

Survey Response

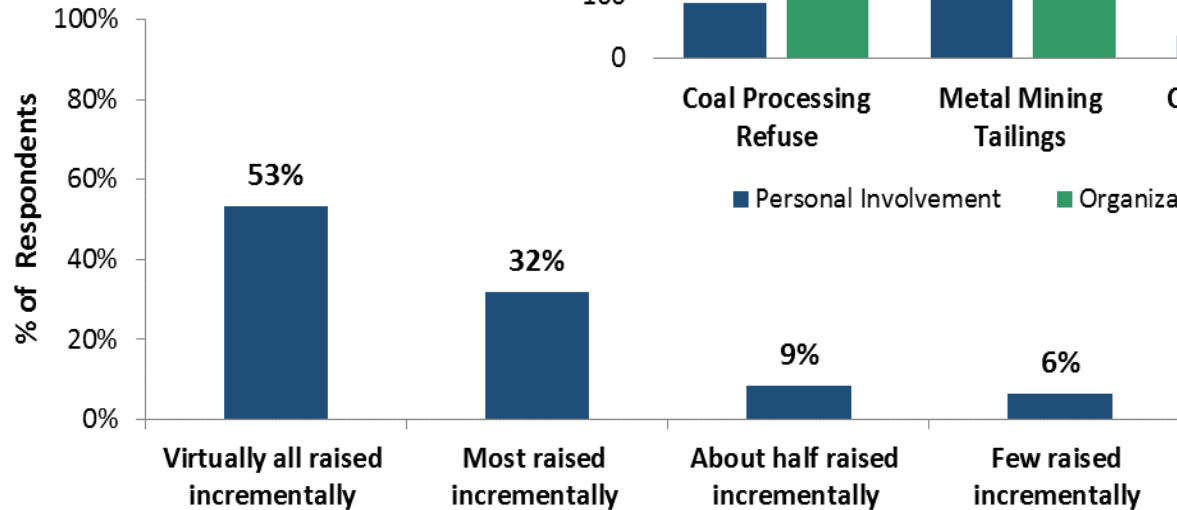
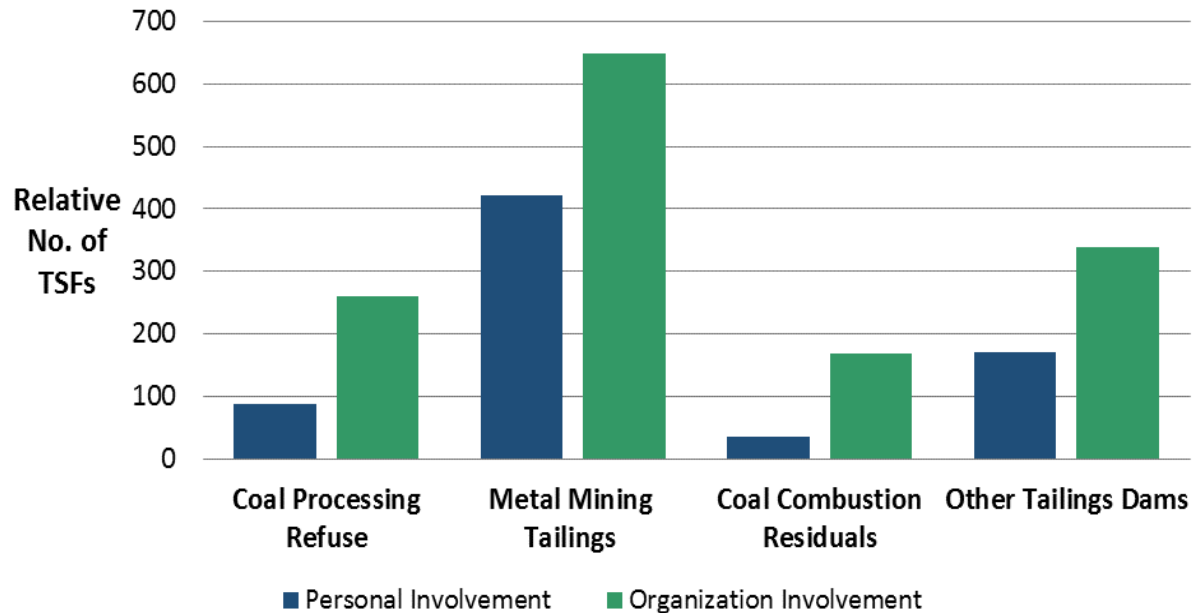
- Period: January 2017
- 51 Responses Received
- 23 Engineering Firms
- 2 State Regulatory Agencies
- 2 Mining Companies

Years of Experience



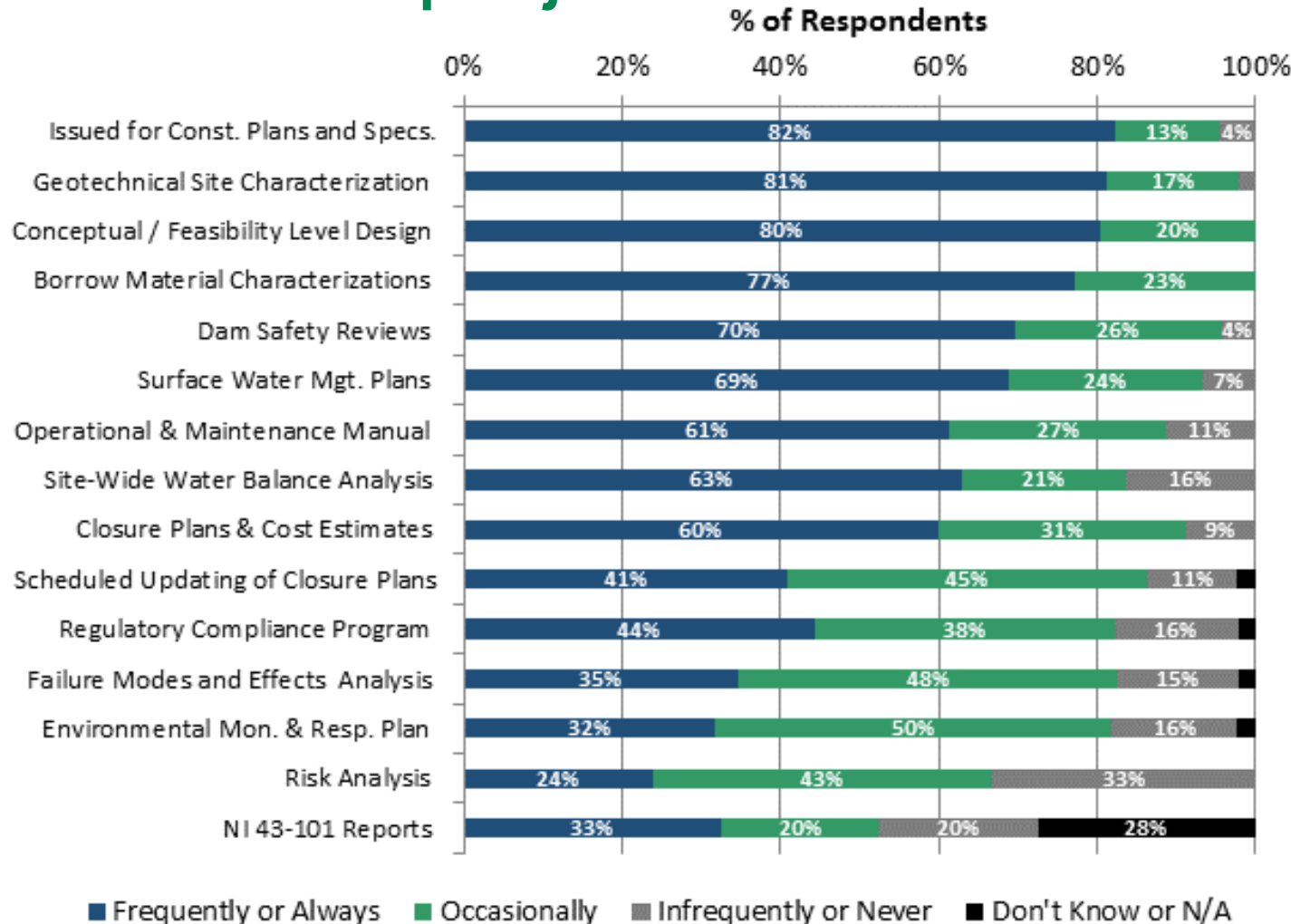
Pre-Workshop Survey – Demographics & Experience

Type of TSF

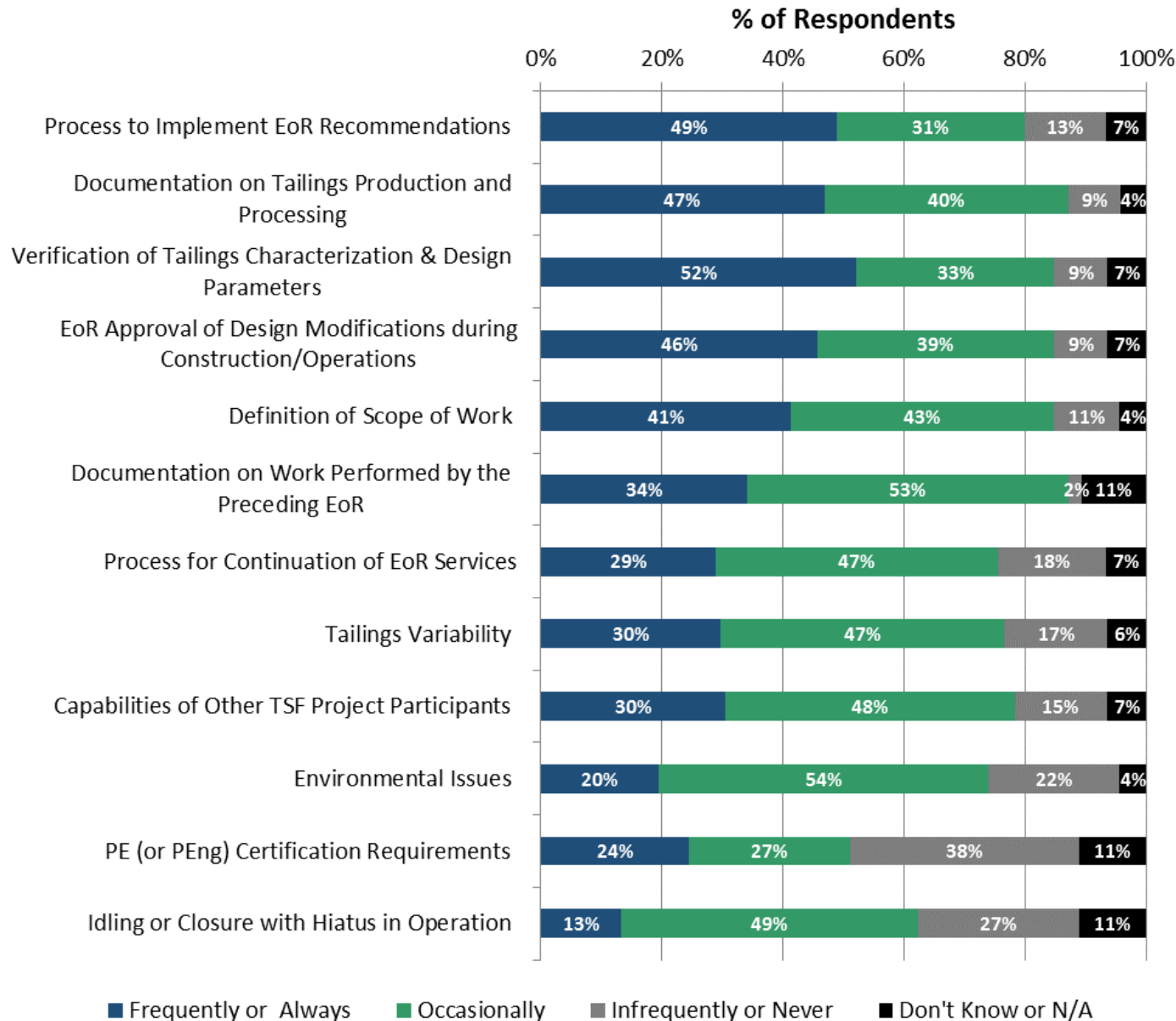


Type of TSF Expansion

Elements of projects with EoR services



Concerns with providing EoR services



Concerns & Strategies for EoR services

EoR Concerns	EoR Strategies
Definition of EoR Scope of Work	<ul style="list-style-type: none">• Communication• Reference to State of Practice• Identification of Roles & Responsibilities• Contract Language
Process to Implement EoR Recommendations	<ul style="list-style-type: none">• Addressed in Scope of Work• Participation of Independent Review Panel• Reporting Responsibility
Approval of Design Modifications during Construction / Operation	<ul style="list-style-type: none">• Distinction between Minor and Major Modification• Definition of Modification and Extent of Approval• Conducted under a Risk Management Plan Acceptable to Owner and Regulator

Concerns & Strategies for EoR services

EoR Concerns	EoR Strategies
Process for Transition/ Continuation of EoR Services	<ul style="list-style-type: none">• Dam Safety Reviews• Project Documents & Design Reviews; QA Checks• Independent Assessment of Potential Risks• EoR Team within Firm and Succession Planning
Verification of Tailings Characteristics	<ul style="list-style-type: none">• Addressed in Scope of Work• Reference to State of Practice

CPT Rig for Tailings
Characterization



Value provided by a competent EoR

- Continuing involvement of the responsible engineer having in-depth knowledge of the TSF, capable of implementing the observational approach to ensure the design philosophy and intent is met over the life of the project
- Delivering leadership across disciplines, providing a resource for the owner in making sound technical and business decisions
- Demonstrating owner's commitments to safety and sustainability to project stakeholders
- Fulfilling regulatory requirements and ensuring QA/QC programs are implemented, project documentation is completed, and inspections are conducted and submitted
- Confirming understanding of owner's staff of the proper methods of operating the facility and
- Prepared to respond should adverse conditions develop

EoR qualifications for TSF projects

- Consensus among workshop attendees:
 - 10 years minimum relevant experience (more as complexity or scale increases)
 - PE in jurisdiction of project, as applicable
 - Relevant experience in TSF design/construction/operations
 - 5+ years of experience managing multi-disciplinary tailings projects
- Excerpt from DIAC's June 2017 White Paper:

The qualifications and experience of the DE and EOR must be commensurate with the risk and complexity of the dam. A typical minimum requirement is a relevant professional undergraduate and/or graduate degree, and 10 years of relevant experience in the design, construction, performance evaluation and/or operation of dams. Additional experience is needed for responsibility for high risk or complex structures. Significant engineering judgment and discretion is required in these roles.

The DSRE, EOR and DE must be registered Professional Engineers in Alberta.

Roles & Responsibilities

DESIGN

	Owner (Accountable Executive)		Designer of Record (DoR)	Engineer of Record (EoR)	Tailings Operation Mgr/ TSF Qualified Person/ Dam Safety Manager	Independent Review Board or Third-Party Reviewer	Regulator
	Internal		External (typical)	External (typical)	Internal	External	External
Design				(DoR)			
Plans & Specifications				(DoR)			
Cost Estimate				(DoR)			
Permitting				(DoR)			Approval
Site Investigation, Analysis & Reports: Tailings Characterization; Geotechnical Exploration; Hydrogeology; Geology; Borrow Material Investigation.				(DoR)			
Operations, Maintenance & Surveillance (OMS) Manual				(DoR)	If designated during design phase		
Environmental Impact & Protection			Dam Portion	(DoR)			
Risk & FMEA				(DoR)			
Emergency Action Plan (EAP)				(DoR)			
Closure Plan				(DoR)			
Regulatory Reporting				(DoR)			
Designating Design Team (in support of EoR)				(DoR)			
Establish Action Threshold Levels				(DoR)			
Financial Assurance				(DoR)			
Const (CAPEX)							
CQA				(Designer)			
Instrumentation				(Designer)			
Construction Report of As-Built				(Designer)			
Construction Management				(Designer)			

Abbreviation	Role
R	Responsible
A	Accountable
C	Consult
I	Inform

- Developed preliminary RACI charts
- Project phases: design, construction, operations & closure

Roles & Responsibilities

- Excerpt from DIAC's June 2017 White Paper:
 - RASCI charts for: (i) large organizations with multiple dams and sophisticated internal resources; and (ii) small organizations with few dams and limited internal resources

	Organizational Group				
	Organizational Accountability	Operational Control	Technical Responsibility		
			Example Roles		
			Accountable Executive (Corporate Owner)	Operations Manager	Dam Safety Responsible Engineer (DSRE)
Organizational					
Set dam safety policy	A	I	R	C	I
Develop and maintain the dam safety management system	A	I	R	C	I
Implement the dam safety management system	A	S	R	S	
Coordinate departments with dam safety roles	A		R	S	
Ensure qualified people undertake work	A	R	R	S	S
Provide technical oversight to manage dam safety risks			A	R	
Commission and implement an Independent Review Board	A	S	R	S	
Investigation and Design					
Site investigation using qualified people and appropriate methods		I	A	C	R
Prepare design report and construction drawings		I	A	S	R
Document design basis, QPOs and expected performance		C	A	C	R
Construction					
Provide resources to construct in accordance with design using appropriate materials and methods	A	R	C	C	I
Verify construction conformance with design		A	I	R	S
Maintain construction and performance records		R	A	R	S
Operations and Maintenance					
Develop and maintain operations procedures and limits		C	A	C	R

	Organizational Group				
	Organizational Accountability	Operational Control	Technical Responsibility		
	Example Roles				
	Accountable Executive (Corporate Owner)	Operations Manager	Dam Safety Responsible Engineer (DSRE)	Engineer of Record (EOR)	Design Engineer (DE)
ince with st QPOs	A	R	S	S	
es		I	A	C	R
mance		S	A	R	C
		S	A	R	I
ports	A	I	R	S	I
	A	S	R	S	
irect		A	C	R	C
risks	A	R	S	S	
			A	R	S
		A	S	R	
is (ERPs)	A	R	S	S	
	A	R	C	C	S
sioning and	A	R	S	S	
	A	S	C	R	
	A	S	C	R	
	A	S	C	R	
endations	A	S	C	R	

Looking to the Future...



Where are we now?

- A small professional community with niche skills
- Experiencing resource redistribution
 - Cyclic attrition during down markets
 - Deemphasis of engineering
 - Movement to State and Federal jobs
 - Private sector
- Attrition (Father Time Yields for No One)
- Require continual “on-the-job” training



Resource Demands

- Ownership
 - Program Director - “Corporate Champion”
 - Internal engineers
- External Reviews
 - EoR direct engagement
 - External support
 - 3rd party reviewers
- Technical Review Boards
 - Academia or private practice experts

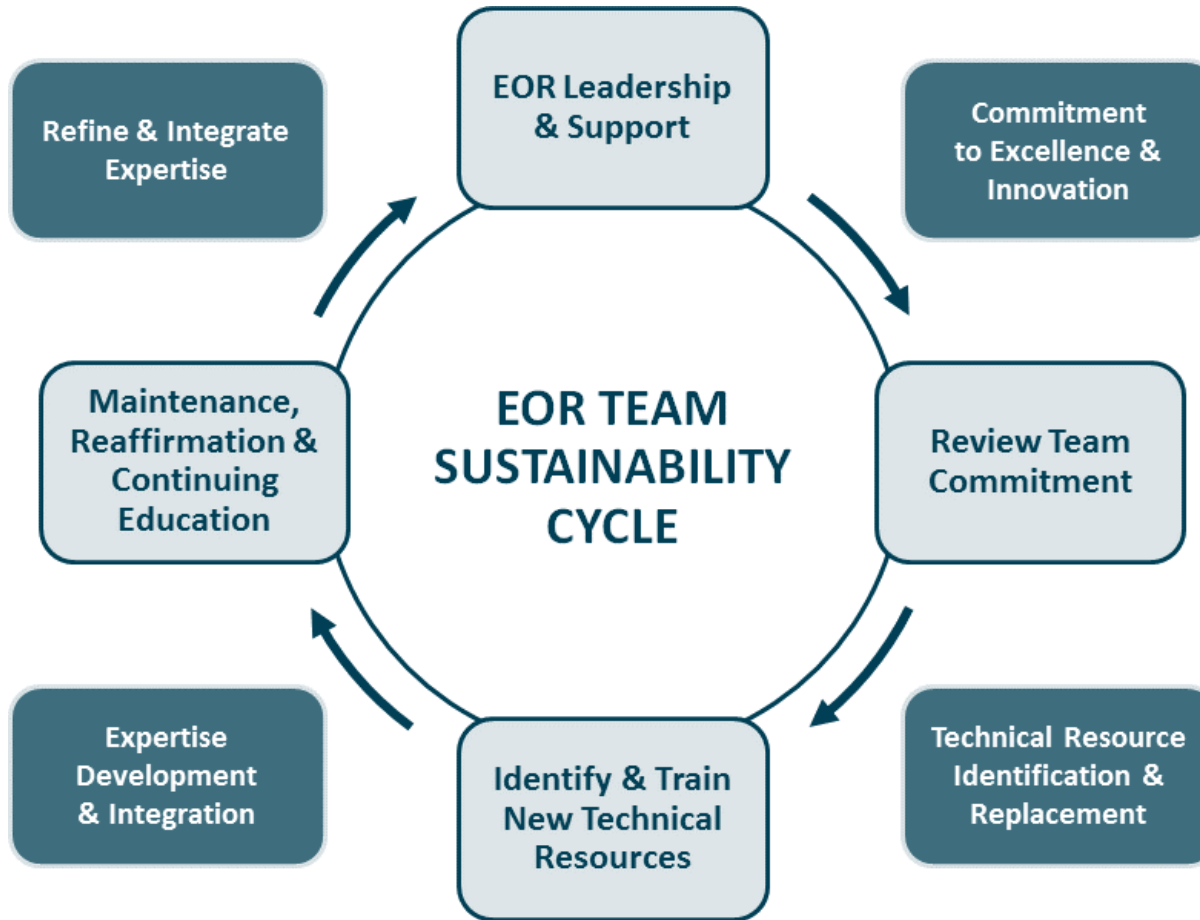


Legacy Planning

- Sufficiently flexible EoR requirements
 - Problem recognition
 - Utilize teams to leverage resources
 - Scalability
 - Data warehousing
 - Attrition planning



Sustainability Cycle



Culmination of Task Force Efforts



- “Best Practices for the Engineer of Record (EoR) for Tailings and Other Mining Dams”
 - Assists in identifying the roles and responsibilities of the EoR
 - Provides guidance to assist in establishing a standard of care for work in the United States and elsewhere in the world
- Document contributed to by:



Let's Do a Quick Survey!

<https://play.kahoot.it/#/lobby?quizId=21d23edd-48e4-4b8a-939b-80c880b89093>

Join this **Survey** at **kahoot.it**
with Game PIN:

then **Pattern**:



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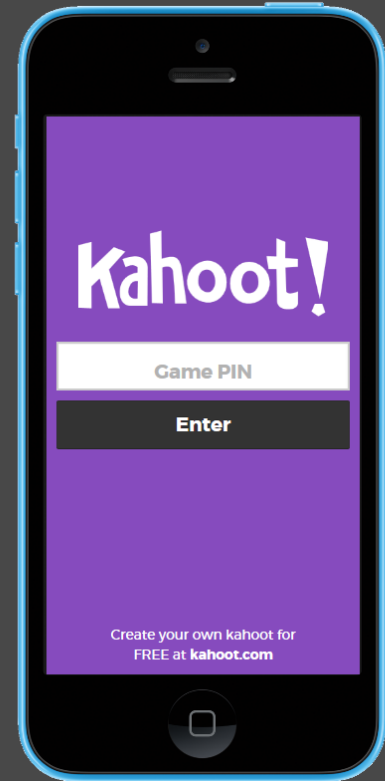
Players

Kahoot!

Start



Waiting for players...





Thank You!