TECHNICAL MEMORANDUM

DATE January 11, 2019 **Project No.** 1788500.002 TM01 Rev0

TO Ms Vicky Peacey, Resolution Copper Mining

CC Jason Nielson

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ALTERNATIVE 5 – IMPACTS ON PUBLIC SAFETY

This technical memorandum summarizes the potential failure modes and other contributing risk factors to the Peg Leg TSF alterative that could lead to downstream impacts, and how those failure modes are addressed in design and the methodology.

1.0 DEFENSIVE DESIGN MEASURES

The design criteria for Alternative 5 are summarized in a clearly stated Design Basis Memorandum (DBM), which is summarized in Appendix A of our report (Golder 2018). In selection of the design criteria, State and Federal regulations as well as national and international guidelines are referenced to ensure that best international design practices are used in addition to meeting regulatory requirements. These best practices are cited to identify that the final design must meet these criteria.

Table 1, attached, takes the design criteria summarized in Table 1 of Golder's Appendix A Design Basis document, and identifies how each potential failure mode or major risk factor is addressed in the design criteria and design itself. Table 1 also identifies the review processes that occur to confirm that the criteria have been met.

2.0 PATH FORWARD TO MINIMIZE PROBABILITY OF FAILURE

The potential failure modes are grouped into the following categories relating to:

- Embankment Stability: Potential embankment stability failure modes are divided into static and seismic failure modes relating to the embankment and the embankment and foundation system. Included under stability are seismic deformations, which may include loss of freeboard, and how liquefaction risk of the tailings and foundation will be addressed. Based on a recommendation by the Independent Technical Review Board (ITRB) for Resolution Copper, all potentially contractive[1] tailing and foundation materials will be treated as potentially liquefiable, regardless of seismic or other trigger mechanism. This treatment of contractive materials is one of the principal findings for the SaMarco Fundao tailings dam failure in Brazil and is very conservative.
- Reservoir failure modes: For completeness, potential reservoir failure modes are evaluated. Due to the relatively gentle topography (4 degrees average slope) of the Peg Leg site, natural failure modes are minimal. The potential failure mode that will be incorporated into future designs is determination of the

[1] Contractive is the technical term for "loose" materials or tailings that could generate excess porewater pressures, which would lead to a reduction in strength.

freeboard requirements to contain failure of the operating potentially acid-generating (PAG) cell into the non-potentially acid-generating (NPAG) impoundment.

- Hydrologic failure modes: Hydrologic failure modes include the potential for diversion facilities to fail, the embankment dams to be overtopped, and erosion or internal piping to lead to embankment failure and/or release of tailings.
- Construction deficiencies and risk factors: The embankment, drainage system, piping system, and other appurtenant features may fail if there is improper construction and specifications are not met. The tailings facility design includes development of drawings and specifications that must be followed. These specifications are confirmed through the development of a quality control testing and quality assurance (QA/QC) program to test and confirm that specifications are achieved during construction.
- Operational risk factors: Operational risk factors include those items relating to improper management, operation, or emergency preparedness of the tailings storage facility (TSF). These factors are largely addressed by following the Mining Association of Canada (MAC 2017) guidelines to the operation of tailings storage facilities. The MAC guidelines provide to the owner best practices to be followed during operation of these facilities.

The above potential failure mode categories and risk factors are summarized in the attached Table 1. This table links the potential failure modes or risk to the Alternative 5, Appendix A design basis technical memorandum, which summarizes the design criteria used. The first column in Table 1 describes the general failure mode or risk factor, the second column describes the appropriate design basis references, the third column designates the item number in the design basis, and the forth column summarizes the reference. The defensive design measures incorporated into the NPAG and PAG facilities are summarized in columns 5 and 6. Column 7 identifies the independent confirmation method used during the design and operation of the facility. Lastly, column 8 summarizes the Alternative 5 report appendix where each potential failure mode is addressed.

To address embankment stability the following elements have been incorporated into the Alternative 5 design:

2.1 Embankment Stability Design Measures

The following design measures have been incorporated into the Alternative 5 design to address embankment stability, the risk of failure, and potential downstream impacts.

- Tailings are separated into NPAG and PAG, and stored in separate facilities. The PAG tailing facilities are located on bedrock and the NPAG facilities are located immediately downslope of the PAG facilities on alluvium.
- Embankments have been designed using centerline construction for the NPAG embankment and downstream construction for the PAG embankment using downstream slopes of 3:1 [H:V]. These construction methods and slopes provide stability, meet or exceed factor-of-safety (FoS) design criteria, and provide acceptable deformations.
- Centerline construction is appropriate for the NPAG embankment due to the wide beach widths, which prevent water from impounding against the embankment. Drainage measures are incorporated below the embankments to provide embankment drainage. The minimum FoS criteria are exceeded using these designs.
- Downstream construction is used for the PAG embankment due to the 10 feet of water cover required for geochemical considerations. The facility will be designed as a water dam founded on bedrock.

Downstream construction allows for various low-permeability and erosion measures to be applied to the upstream slope, including a wide low-permeability seepage control zone and/or geosynthetic lining of the embankment.

- For seismic design, a site-specific hazard study was completed for Alternatives 2 and 3, and the results are applicable to the Alternative 5 Peg Leg site. The seismic design criteria include a maximum credible earthquake (MCE) input ground motion to meet seismic stability. The MCE has an approximate return period of 1 in 10,000 years. If Peg Leg is the selected site, a site-specific hazard analysis will need to be completed for the Peg Leg site itself. Empirical assessment of the maximum deformations has been made, and if Peg Leg is the selected alternative, a detailed seismic deformation analysis will need to be completed.
- At the recommendation of the ITRB, all loose materials such as beach tailings are treated as "contractive," or subject to build-up of pore pressure due to either a seismic or other trigger (e.g., strain). This is a very conservative assumption that assumes saturated materials will posses liquefied shear strengths, which are significantly lower than the drained shear strengths used in static analysis.
- Foundation investigations are underway to assess the static and seismic shear strength of the foundation materials. These investigations are crucial to understand whether contractive materials (loose sands and gravels) are present in the foundation. Should such materials be encountered, they will need to be removed and/or mitigation measures will need to be implemented. The findings of the foundation investigations are crucial to calculate the overall static and seismic FoS of the TSF. The current design assumes removal of unsuitable materials in the foundation, and this assumption will need to be verified.

2.2 Hydrologic Design Measures

The following design measures are incorporated to address potential hydrologic failure modes, including internal erosion:

- The Peg Leg site is located immediately to the west of the drainage divide forming the Tortilla Mountain range, therefore the upstream diversion requirements are modest.
- Ditches that prevent the inflow of water to the NPAG and initial PAG facilities are designed to divert a 24-hour, 200-year storm, which is twice that required by Arizona Best Available Demonstrated Control Technology (BADCT) criteria.
- The NPAG embankment freeboard is designed to contain the probable maximum precipitation (PMP) of all upslope watersheds in the event of a breach of the diversion ditches.
- The upstream slope of the PAG embankment will be provided with erosion protection. The present design includes a 20-foot-wide low-permeability zone. This design may be upgraded to include riprap and/or geosynthetic lining such as an asphaltic membrane liner.
- To prevent internal erosion, the embankment drainage measures will be designed to filter criteria to prevent clogging and particle migration. Geosynthetic materials will not be used in any critical filters (defined as a filter zone that, should it not perform as intended, could lead to embankment instability).
- Embankment drains will be designed with a conveyance capacity 10 times of that expected by seepage analysis (considered to be a drainage safety factor).
- Conduits through or below the embankment will be avoided. Should a need to provide a conduit below the embankment be required, the conduit will be designed to withstand the embankment stresses and encased in concrete to prevent piping outside the conduits.

- A seepage collection system consisting of lined ditches, ponds, pumps for surface water, and a groundwater pump back system will be constructed to capture both surface and groundwater to pump back to the mill for reuse.

2.3 Reservoir Design Measures

Golder did not identify any reservoir failure modes due to the gentle slope of the natural topography and location of the Peg Leg site immediately to the west of the drainage divide (which runs along the Florence-Kelvin highway to the east of the site).

2.4 Construction Deficiencies

To confirm that the construction meets the intended design criteria, construction drawings and specifications will be developed and must be met. Specifications normally use accepted testing and verification procedures through design, investigation, and construction, such as American Society of Testing and Materials (ASTM) and/or American National Standards Institute (ANSI) procedures. The specifications are accompanied by a QA/QC program. QC consists of physical testing of the materials that are placed in the embankment, foundation preparation, and other construction. QC is typically completed by the contractor through an independent firm. QA is the process of validating that the QC testing adequately represents the construction and is performed by the design engineer or by an independent group.

2.5 Operational Considerations

One of the unique design and construction aspects of tailings dams is that these facilities are often designed in stages and constructed over a very long lifespan, which is 41 years in the case of the Resolution Copper Project. Therefore, the proper continued design, operation, and management is vital to the safe operation of the facility. Guidelines for the safe operation of the facility are described in A Guide to the Management of Tailings Facilities (MAC 2017) and the Review of Management Guidelines and Recommendations for Improvement (ICMM 2016). In addition, the observational method is used in tailings dam design to assess the operational performance, identify behaviour that varies from the design intent, and identify design options and mitigation measures in advance of potential unacceptable performance. The observational approach places heavy reliance on a thorough monitoring and instrumentation program that is described in an Operations, Maintenance and Surveillance (OMS) Manual. Lastly, Rio Tinto has an internal standard (D5 – Management of Tailings and Water Storage Facilities) that will be followed to ensure that internationally recognized practices are observed and operational risks are minimized throughout the life and closure of the facility.

Operational risks are addressed by development of the OMS Manual that addresses all aspects of the operation. Key to stability is the surveillance of the facility by development of a geotechnical monitoring system. The geotechnical monitoring system normally involves the installation of piezometers, inclinometers, and survey means to assess the performance of the facility. Each instrument in the geotechnical monitoring program has a threshold value identified that indicates whether the measured parameter is within the analysed design parameter or is approaching a threshold value. This approach is key to identifying potential stability issues before they are manifested so that corrective actions can be taken.

2.6 Independent Verification and Reviews

The design and operation of the tailings dam includes assurance processes that are followed to confirm that design and operations criteria are followed. Column 7 of Table 1 identifies assurance review processes that are followed to confirm that the design criteria are adhered to. These process steps include:

- Design review processes that confirm that design criteria are followed and incorporated into design.
- Construction QC and QA processes that confirm that the facility is constructed as designed.

- Operating review process steps that are followed to confirm that the OMS Manual is being followed and periodically updated to reflect changing conditions.

3.0 CONCLUSION

The owner, regulatory agencies, design engineer, and independent reviewers each agree that the consequences of embankment failure are considered to be unacceptable. To mitigate against the potential consequences of embankment failure, stringent design criteria have been developed and are summarized in a DBM. This technical memorandum summarizes how potential failure modes are addressed by the DBM and identifies how a number of review cycles are incorporated during the design, construction, and operation stages to reduce embankment failure risks to a minimum. These reviews occur in parallel with the design through operation processes.

The overall process steps consist of a relatively linear process of design, permit, construction, and operation. During each of these stages there are independent review cycles. These consist of design reviews, permit reviews, construction reviews, and operation reviews by individuals independent from the TSF operations. Individuals include the ITRB, representatives of the permitting agencies with specific expertise in tailings dam design, independent QC/QA firms (during construction) and the Engineer of Record. These parallel processes are depicted in Figure 1.

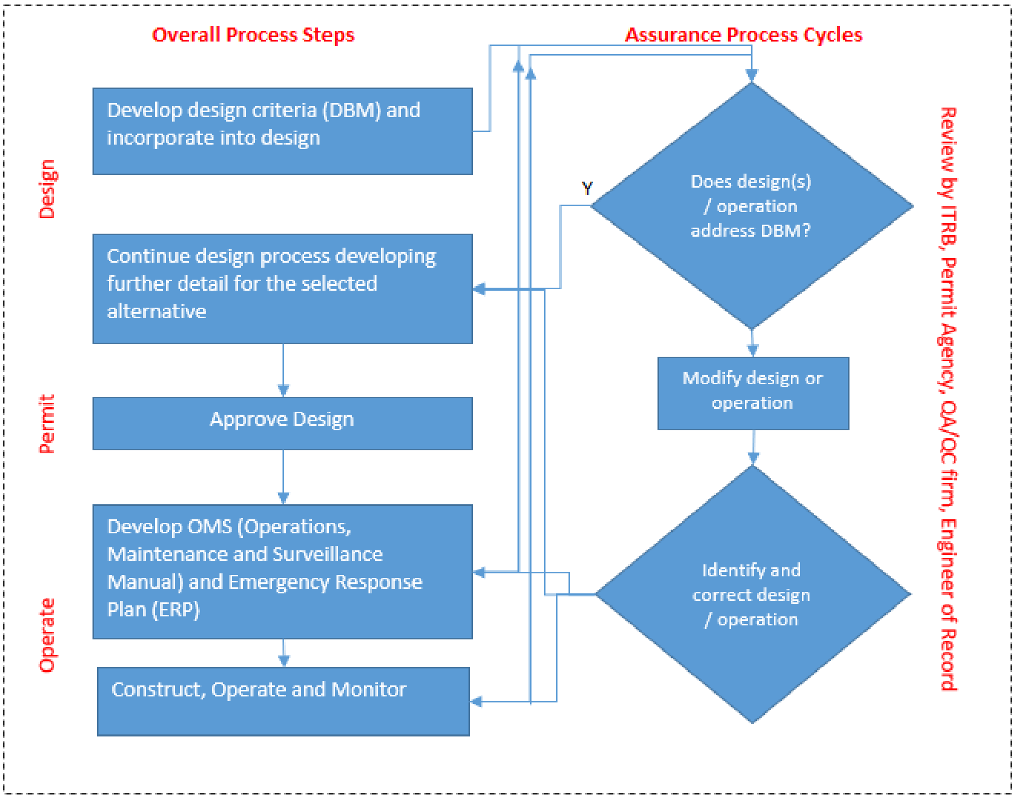

Figure 1: The Relatively Linear Design Process Paralleled by Review Cycles

The TSF facility is considered a robust tailings dam design. The design incorporates both centerline and downstream construction methods. Seismic and hydrologic input parameters and other potential failure modes have been considered and incorporated into the design to reduce risk. As the design evolves through the permitting process, a formal Failure Modes Effects Analysis (FMEA) will be completed for the selected alternative and presented in the final Environmental Impact Statement (EIS). As such, the dam is expected to have a very low probability of failure in a formal FMEA during the MCE or overtop during the PMP event as well as other failure mechanisms and would remain functional.

4.0 REFERENCES

Golder Associates Inc. (Golder). 2018. Draft EIS Design – Peg Leg Site Alternative 5. June 20, 2018. Project 1788500-1000-1600-16-R-0

International Committee on Large Dams (ICOLD). 2001. Tailings Dams Risk of Dangerous Occurrences, Bulletin 121.

International Council on Mining and Metals (ICMM). 2016. Review of Management Guidelines and Recommendations for Improvement.

Mining Association of Canada (MAC). 2017. A Guide to the Management of Tailings Facilities, 3rd Edition.

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Attachments: Table 1 – Alternative 5 – Peg Leg – Potential Geotechnical (Dam Safety) Failure Modes, Risks, and Design Criteria

https://golderassociates.sharepoint.com/sites/101376/deliverables/final/tm01/1788500.002_alt5_public_safety_tm_rev0_11jan19.docx

TABLE 1

Alternative 5 – Peg Leg – Potential Geotechnical (Dam Safety) Failure Modes, Risks, and Design Criteria

Table 1: Alternative 5 - Peg Leg - Potential Geotechnical (Dam Safety) Failure Modes, Risks, and Design Criteria (Including Means of Addressing Risk and Confirming Failure Mode Mitigation)

Potential Failure Mode and Contributing Risk Factor	Design Basis Reference (International Standard or Regulatory Criteria)	Design Criteria (DBM App A Item No.)	Reference Description	Defensive Design Measure		Assurance Process	Alt 5 Report Reference (assurance reference)
Column 1	**2**	**3**	**4**	**5 NPAG facility**	**6 PAG facility**	**7**	**8**
<u>TSF Embankment Stability</u>							
Identify embankment consequence classification	CDA (2013) RT D5	1.01a 1.01b	Identifies whether the facility is a low to extremely high hazard facility and determines appropriate seismic and flood design criteria	Both embankment types / facilities identifed as high consequence classification		A - Design Review Process:	Appendix A
Static Failure - embankment only	BADCT (ADEQ 2004) with MEM (2016) CDA (2013) RT D5 Standard	1.03 1.04	Identifies minimum factor of safety of dam, appropriate embankment slopes	Design incorporates 3:1 [H:V] downstream slopes for closure and erosion protection, although minimum slopes of 2:1 (Hor:Vert) identified. Centerline construction selected to meet Factor of Safety and constructibility criteria	Downstream slopes of 3:1 [H:V] selected for erosion control and closure, meeting minimum Factor of Safety criteria. Downstream construction selected to allow for potential lining of PAG cells and standing water against embankment and erosion protection	A - Design Review Process:	Appendix E
Static Failure - embankment on foundation			- As above, plus - Confirm shear strength characterization of foundation materials	Complete detailed, thorough field investigations prior to FEIS		A - Design Review Process:	Appendix E
Seismic Failure - embankment	BADCT (ADEQ 204) CDA (2013) BC MEM (2016) RT D5	1.04 1.05 1.06 1.07	- Identifies minimum seismic factor of safety, - allowable deformation to prevent overtopping and excess deformation and - how liquefied materials will be addressed in design	- Embankments are designed to an MCE (Maximum Credible Earthquake) assumed to be equivalent to an event with a 10,000 year return period. - For operations, facility is designed to withstand 1,000 year return period and remain in operation - Under MCE design, impoundment would not fail, but may require mitigation to be back in operation - Embankment deformations (settlement) would not permit overtopping by tailings or reclaim pond and - transverse cracks would be prevented to reduce risk of internal erosion.		A - Design Review Process:	Appendix E
Seismic Failure - embankment on foundation			Confirm seismic shear strength characterization and liquefaction susceptibility of foundation materials	Complete detailed, thorough field investigations before FEIS		A - Design Review Process:	Appendix E
Seismic Deformation Risk - loss of freeboard and overtopping	(<u>Methods</u>): Hynes-Griffin and Franklin (1984) Bray and Tavasaru (2007)		Estimate seismic deformations to prevent overtopping or excessive displacements	Calculate seismic deformations for embankments. Use empirical approaches initially and complete formal finite element method deformation analysis for final design.		A - Design Review Process:	Appendix E

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Potential Failure Mode and Contributing Risk Factor	Design Basis Reference (International Standard or Regulatory Criteria)	Design Criteria (DBM App A Item No.)	Reference Description	Defensive Design Measure		Assurance Process	Alt 5 Report Reference (assurance reference)
Column 1	**2**	**3**	**4**	**5 NPAG facility**	**6 PAG facility**	**7**	**8**
Liquefaction Risk - tailings	ITRB recommendation	1.07	Identifies whether liquefaction will be addressed by seismic triggering or conservative post earthquake behavior assumption	- Analyses conservatively assume that hydraulically deposited tailings are collapsible (contractive) and subject to seismic strength loss. - Appropriate post earthquake shear strengths used in analysis to reflect reduced shear strength. (This assumption essentially eliminates the upstream construction method.)		A - Design Review Process:	Appendix A
Liquefaction Risk - embankment	BADCT (ADEQ 2004) Hynes-Griffeth (1984) ITRB recommendation	1.06 1.07	Describes how potentially contractive (liquefiable) foundation materials will be addressed	Embankments will be constructed with dense, non-liquefaction susceptible materials that are not subject to strength loss under shaking (well draining, dilatant, cyclone sands)		C - Both Design and Operating processes	Appendix A
Liquefaction Risk - foundation				- Detailed foundation investigations to be completed to evaluate liquefaction potential of alluvium. - Loose, near surface materials will be removed down to non-liquefaction susceptible materials	Potentially liquefiable materials would be removed down to (shallow) bedrock	A - Design Review Process:	To be addressed with site investigations
Foundation strain or softening	BADCT (ADEQ 2005)	1.05	High shear stresses in foundation or base of embankment cause deformation, sliding or other form of movement	Evaluation foundation stresses under 300 ft high embankment and use appropriate shear strengths	Evaluation foundation stresses under 200 ft high embankment and use appropriate shear strengths	A - Design Review Process:	To be addressed with site investigations
<u>Reservoir Failure Modes</u>							
Landslide or reservoir instability	MAC 2017 BC MEM (2016)	1.17	Evaluate features in reservoir area that could cause failure into the impoundment / reclaim area leading to overtopping of the embankment due to seiche wave, insufficient freeboard or other catastrophic event.	- Landslide not an issue due to mostly flat, gentle topography and slope - Construction of upstream catchment inot the design. - In future Golder to evaluate failure of PAG cell into NPAG and provide freeboard to contain PAG cell failure.	- Landslide not an issue due to mostly flat, topography and slope. - Due to four sided configuration there are no reservoir failure modes. - Reservoir failure modes are related to embankment stability.	A - Design Review Process:	Appendix B - No hazard identified
<u>Hydrologic Failure Modes</u>							
Design and operation of diversion and surface water conveyance facilities	BADCT (2004)	1.08	Provides design criteria for storm events during operation of the facility to reduce probability of overtopping diversion structures and ancilliary facilities.	- Upstream diversions designed to 200 yr event (2 X BADCT requirement) - In the event of diversion failure, NPAG facility is designed to accommodate PMF (Probable Maximum Flood) flood inflow without overtopping	- Same design criteria as PAG facility, although overland flow could not enter four sided PAG facility shortly after construction, so the risk due to diversion failure is eliminated.	C - Both Design and Operating processes	Appendix F

Table 1: Alternative 5 - Peg Leg - Potential Geotechnical (Dam Safety) Failure Modes, Risks, and Design Criteria (Including Means of Addressing Risk and Confirming Failure Mode Mitigation)

Potential Failure Mode and Contributing Risk Factor	Design Basis Reference (International Standard or Regulatory Criteria)	Design Criteria (DBM App A Item No.)	Reference Description	Defensive Design Measure		Assurance Process	Alt 5 Report Reference (assurance reference)
Column 1	**2**	**3**	**4**	**5** **NPAG facility**	**6** **PAG facility**	**7**	**8**
Overtopping dam	BADCT (ADEQ 2004) CDA (2013) FEMA (2013) USACOE (2004) RT D5	1.08 1.09 1.10	A variety of overtopping events are evaluated including: - overtop due to maximum flood event - overtopping due to wave runup - overtopping due to seismic deformation or settlement of dam - overtopping due to failure of PAG cell	- Freeboard is sufficient to accommodate seismic settlement, failure of diversion facilities, wave runup in reclaim pond and store probable maximum precipitation (PMP) event. - Future design to accommodate failure of operating PAG facility (i.e. provide freeboard to accommodate operating PAG cell water and tailings)	- Freeboard sufficient to accommodate seismic settlement, wave runup by water cover and ability to store probable maximum precipitation (PMP) event, all with a 2 foot safety factor.	C - Both Design and Operating processes	Appendix E
Internal Erosion / piping	USACOE (2004)	1.13	Satisfy USACOE requirements for filter design to provide internal erosion and prevent piping failures	Design toe drains to prevent infiltration of cyclone sand and tailings into the toe drain and prevent clogging. Use natural versus synthetic materials to prevent clogging and degradation (consider drains critical filters)	Same as NPAG facility, but due to storing water against the embankment add redundancy to the design to prevent piping (example: liner with backup). Filters considered as critical filters (assume that if filter fails, then embankment could fail).	C - Both Design and Operating processes	To be evaluated at FEIS design
Excess seepage	USACOE (2004)		Design seepage collection structures (toe drain, conveyance, ponds) for sufficient excess flow and storage capacity	Design internal drainage (blanket drain) to accommodate 10X the seepage flows estimated by analyses (i.e. incorporate safety factor of 10X in seepage capacity)		C - Both Design and Operating processes	To be evaluated at FEIS design
Inadequate internal drainage capacity			Prevent phreatic surface from daylighting embankment causing erosion and sloughing			A - Design Review Process:	To be evaluated at FEIS design
Surface erosion leading to overtopping			Design adequate slope lengths and ditches to prevent erosion of embankment	Considered environmental consequence, not life threatening		D - Combination of Design and Operating review (A&C) processes	To be evaluated at FEIS design
Erosion / wave action			Provide sufficient allowance for wave runup to prevent embankment erosion, wave action and potential overtopping due to embankment erosion loss	NPAG facility is provided with sufficient tailings beach width to prevent reclaim pond from encroaching on embankment	- PAG facility is provided with erosion protection for water cover, such as rip rap, sacrificial zone, and/or synthetic lining. - Secondary liner material is sufficiently wide to permit erosion without undermining embankment	C - Both Design and Operating review processes	To be evaluated at FEIS design

Table 1: Alternative 5 - Peg Leg - Potential Geotechnical (Dam Safety) Failure Modes, Risks, and Design Criteria (Including Means of Addressing Risk and Confirming Failure Mode Mitigation)

Potential Failure Mode and Contributing Risk Factor	Design Basis Reference (International Standard or Regulatory Criteria)	Design Criteria (DBM App A Item No.)	Reference Description	Defensive Design Measure		Assurance Process	Alt 5 Report Reference (assurance reference)
Column 1	**2**	**3**	**4**	**5 NPAG facility**	**6 PAG facility**	**7**	**8**
Conduit failure or Piping around outlet conduits	ITRB recommendation	1.13	- Conduit perforations are generally discouraged through embankment and if used must be carefully designed with redundancy. - If incorporated into embankment must be prevented from crushing, collapsing or allowing seepage on the exterior of the conduit.	- Avoid placement or minimize use of conduits (pipes) through base of facility - Use conservative, redundant designs for embankment perforations - Use natural drain materials with proper filter designs (versus geosynthetics that may clog) - If conduits are required, place in trench and backfill trench with concrete low strength material (CLSM)		C - Both Design and Operating processes	To be evaluated for FEIS stage
Operational Risks							
Assure management accountability	RT D5 CDA 2013 MAC 2011, 2017 ICMM 2016	RT D5	Develop operations, maintenance and surveillance (OMS) manual to define accountabilities and assure that funding is available so that accountabilities are met	- Develop OMS manual for final design - Agency bonding requirements		C - Both Design and Operating processes	OMS manual to be developed for Operations
Loss of power	MAC (2011, 2017)	2.06	Design facility to accommodate a power failiure by providing gravity drainage and sufficient storage capacity until emergency backup systems (generators) are available	Design toe collection ponds and reclaim pond storage capacities to accommodate operational upsets due to power failure	Same as NPAG, except elevated cells have less inflows during power failure	C - Both Design and Operating processes	OMS manual to be developed for Operations
Inadequate operation or maintenance	MAC (2011, 2017) ICMM (2016)	RT D5	Confirm that the facility is operated in accordance with design intent	- Develop OMS manual for FEIS design - Develop program for annual Engineer of Record (EoR) reviews - Continue independent technical review boards (ITRB) - Adhere to Rio Tinto D5 standard requirements - Complete accurate capital and operational cost estimates and review estimates		C - Both Design and Operating processes	OMS manual to be developed for Operations

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Potential Failure Mode and Contributing Risk Factor	Design Basis Reference (International Standard or Regulatory Criteria)	Design Criteria (DBM App A Item No.)	Reference Description	Defensive Design Measure		Assurance Process	Alt 5 Report Reference (assurance reference)
Column 1	2	3	4	5 NPAG facility	6 PAG facility	7	8
Inadequate monitoring	MAC (2011, 2017) ICMM (2016)	RT D5	Assure that a geotechnical monitoring program is developed which checks and confirms design assumptions	Develop geotechnical monitoring and surveillance program and include in OMS manual for FEIS		C - Both Design and Operating processes	OMS manual to be developed for Operations
Inadequate emergency preparedness	MAC 2017 12 AAC 15 BC MEM (2016)	RT D5	Tailings storage facilities must have an appropriate emergency response plan	Develop Emergency Response Plan based on inundation study		C - Both Design and Operating processes	OMS manual to be developed for Operations

Acronyms:

Organizations, Standards and Guidelines

12 AAC 15 Title 12, Chapt 15 Arizona Administrative code - Dept of Water Resources
ADEQ Arizona Department of Environmental Quality
BADCT Best Available Demonstrated Control Technology
BC MEM British Columbia Ministry of Energy and Mines
CDA Canadian Dam Association
EoR Engineer of Record
ICMM International Council on Mining and Metals (ICMM)
ICOLD International Committee on Large Dams (ICOLD)
ITRB Independent Technical Review Board
MAC Mining Association of Canada
MEND Mine Environment Neutral Drainage Program
RT D5 Rio Tinto D5 Standard - Tailings and Water Storage Facilities
USACOE United States Army Corps of Engineers

Environmental

AMD Acid Mine Drainage
NPAG Non-potentially Acid Generating
PAG Potentially Acid Generating

Construction Specifications

ASTM American Society of Testing and Materials
ANSI American National Standards Institute

References:

Bray and Travasarou, "Simplified Procedure for Estimating Earthquake Induced Deviatoric Slope Displacments, ASCE Journal Geotehnical and Geoenvrionmental Eng. Vol133, No. 4, April 2017.

Hynes-Griffen and Franklin, "Rationalizing the Seismic Coefficient Method," USACOE, Misc Paper GL-84-13, July 1984.

Peck, R.B. "Advantages and Limitations of the Observational Method in Applied Soil Mechanics," Geotechnique. 19(2): p 171-187.

Assurance Review Processes:

A - Design Review Process: Review by ITRB, EIS Consultant, Federal Regulatory Agency, State Regulatory Agency & EoR sign off

B - Operating Review Process: Confirmation that the OMS manual remains applicable and is being followed. Accomplished by Owner documentation / records, EoR review of monitoring and operations, and ITRB review.

C - Both Design and Operating processes A combinations of the above design and operating review processes