Reducing Long Term Risk at the Candelaria Tailings Storage Facility

Antonio Sotil, M.A.Sc., P.Eng.
Knight Piésold Consultores S.A., Lima, Peru

Victor Soto
Compañía Contractual Minera Candelaria – Lundin Mining, Santiago, Chile

Ken Brouwer, P.Eng.
Knight Piésold Ltd., Vancouver, Canada

ABSTRACT: The Candelaria Mine is an active open pit copper mine operated by Compañía Contractual Minera Candelaria located in the Atacama region of Chile, 20 km south of Copiapó. The Candelaria Tailings Storage Facility (TSF) was deactivated in 2018 and a surface cap is planned for closure of the impoundment. Mining activities will generate approximately 800 Mt of waste rock during ongoing open pit mining operations, and the decommissioned TSF provides an opportunity for TSF closure capping activities to be integrated with long term waste rock disposal. Capping the Candelaria TSF will provide significant storage capacity for waste rock within a reasonable hauling distance from the open pit, reduce additional site disturbance during ongoing mine operations, and minimize post-closure water management by providing a naturally-appearing convex, free-draining, stable post-closure landform. As an added benefit, the waste rock load will promote consolidation, densification, and dewatering of the underlying tailings, further reducing the potential for the impounded tailings to fluidize and flow in the event of a hypothetical dam breach. The closure cap will be developed on the Candelaria TSF by progressive placement of a thick (20 m to 60 m) waste rock cap with flat 20H:1V overall slopes. Engineering work to support permitting applications includes detailed field studies to characterize the current and future tailings behaviour, and design studies to optimize the final geometry, supported by geotechnical analyses. The field component incorporates two site investigation programs to evaluate tailings properties before and after construction of two 30 m high surcharge loads simulating the future loading during the staged development of the closure cap. The closure cap will provide economic benefits for secure waste rock storage, while enhancing impoundment stability as the tailings mass is stabilized through stress densification. These improvements will lead to a reduction in the risks associated with the project, both during ongoing mine operations and after closure of the facilities.

1 INTRODUCTION

Tailings from hard rock copper mining operations typically comprise fine-grained sand, silt, and clay sized rock fragments mixed with water to facilitate slurry transport and deposition into the tailings impoundment. The characteristics of the tailings deposit can vary significantly between different mine sites and depend on material characteristics, impoundment filling rates and the extent that free water is recovered and/or removed from the facility. Loose saturated tailings can be present within certain areas of tailings impoundments, and these soft, saturated tailings can represent a potential hazard, particularly if the materials are sufficiently wet such that a mudflood or mudflow could develop from a hypothetical dam breach scenario (Martin et al, 2019). This risk must be managed throughout the life cycle of a mine, and necessary objectives are to provide for long-term public safety and protection of valued components of the ecosystem such as air, surface water, and groundwater resources.

It can be challenging to demonstrate long-term stability after closure given the complexity and uncertainty associated with future performance predictions. During the post-closure period, there is the potential for changes in the local environment, land use, meteoric conditions, topography, geology, and state of practice. Increasing the density and reducing the flowability of the tailings within a tailings impoundment can reduce the consequence of a hypothetical dam breach and de-risk the tailings impoundment following closure (Adams et al, 2018).

Modern tailings impoundments are commonly closed in phases (CDA, 2014). The active closure phase begins once the impoundment reaches the ultimate capacity or the mine ceases production, and typically involves the construction of a closure cap to form a stable landform and minimize dusting. The impoundment is closely monitored for a number of years during the active closure phase and will transition to passive closure once the long term physical and chemical stability of the impoundment has been demonstrated. The surfaces of many tailings impoundments have been reclaimed by shaping, capping, and revegetation, but there are fewer examples where the tailings pile can be shown to be suitably stabilized to a landform condition, with no potentially flowable materials impounded (Adams et al, 2017c).

This paper presents a case history for the closure design and proposed closure enhancement for the Candelaria Tailings Storage Facility (TSF) at the Candelaria Mine. Additional waste rock disposal capacity is required for ongoing operations. This provides an opportunity to integrate the waste rock dump arrangements with closure capping at the TSF, and to promote the development of a stable post closure landform at the Candelaria TSF. The integrated waste rock closure capping strategy has been named the El Buitre Closure Cap (EBCC). There are also opportunities to simplify the storm water management systems during operations and particularly for the post closure site arrangement by incorporating suitable drainage and diversions along the upslope portion of the proposed EBCC.

Placement and storage of waste rock on the decommissioned tailings impoundment will result in increased consolidation, dewatering, and densification of the underlying tailings. This will further stabilize and de-risk the closed tailings impoundment by reducing the potential for the impounded tailings to flow in a hypothetical dam failure scenario. Additionally, use of areas already affected by the mine operations for waste rock storage will reduce the need for new site disturbance and minimize the overall environmental impact of the ongoing mining operations. These improvements will lead to a reduction in the risks associated with waste management at the project, during the operations, closure, and post-closure phases (Adams et al, 2019).

2 PROJECT OVERVIEW

The Candelaria Mine has been in operation since 1993 and is currently operated by Compañía Contractual Minera Candelaria (CCMC). The key waste and water management facilities include the Candelaria TSF, the more recently commissioned Los Diques TSF, and several waste rock disposal sites including the North Waste Dump, and the proposed EBCC. A general arrangement of the mine site illustrating key facility locations and future expansion areas is shown on Figure 1. Tailings deposition transitioned from the Candelaria TSF to the Los Diques TSF during 2018 and 2019. Tailings deposition into the Candelaria TSF ceased completely by the end of 2019.

The Candelaria TSF includes a Main Embankment and two saddle embankments (North and South) and a seepage collection system (SCS). The SCS collects drainage via an underdrain system excavated into the underlying alluvium at the Starter Embankment and is conveyed towards the cut-off trench downstream of the Main Embankment. Seepage water is recovered by pumping wells (named Pique Mina) located upstream of the cut-off trench and transferred to the plant for use as process water. During past operations, a reclaim barge and pump were located at the southeast corner of the TSF, where reclaim water was pumped from the slimes pond to the concentrator for use in processing. Figures 2 and 3 show an overview of the Candelaria TSF and the location of the SCS. Hydrogeology studies concluded that all seepage water to the SCS was coming from the tailings pond. Phreatic conditions within the Candelaria TSF are significantly less than hydrostatic with actual measured equilibrium pore pressures (from Cone Penetration Testing (CPT) pore pressure dissipation tests) plotting well below the hydrostatic line in all cases. All pore pressure dissipation tests conducted between 2014 and 2020 yielded pore pressure profiles with total head decreasing with depth, indicating that the tailings are draining downwards.

Figure 1. General Mine Site Arrangement

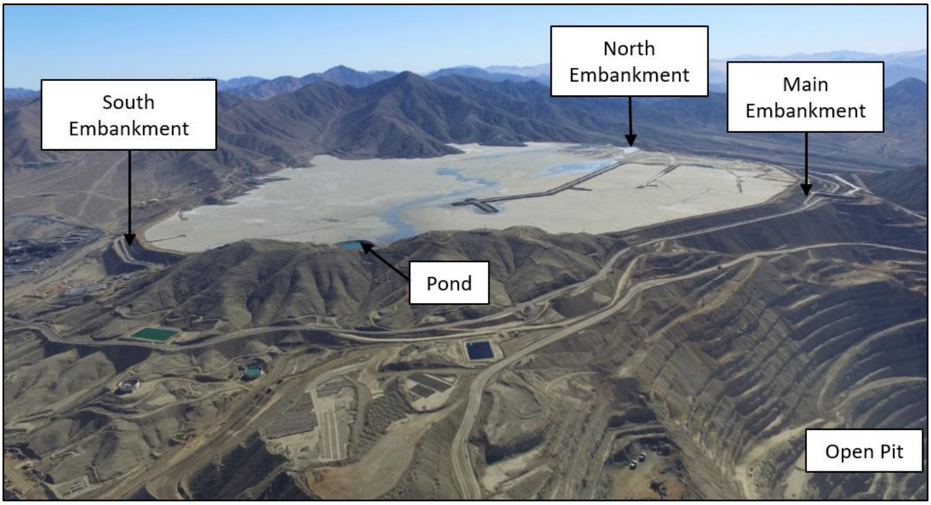

Figure 2. Candelaria TSF Overview

Foundation materials within the Candelaria TSF are generally comprised of alluvium deposits, which are typically dense sandy gravel with an average thickness of 20 m. The alluvium materials are underlain by fractured bedrock to a depth of approximately 30 m, with less fracturing below this depth. Tailings draindown indicates that the alluvial foundation material is significantly more permeable than the tailings and provides a drainage zone at the base of the impoundment.

Seepage flows captured at the Pique Mina consistently decrease with time after decommissioning of the Candelaria TSF. Measured annual pumping flows collected at the SCS were around 300 l/sec in 2018 when tailings deposition ceased at the Candelaria TSF and were less than 220 l/sec at the end of Q2 2020. Some ongoing seepage relating to draindown in the tailings mass is anticipated, as well as from seepage caused by consolidation-induced pore water expulsion during future EBCC loading on the Candelaria TSF.

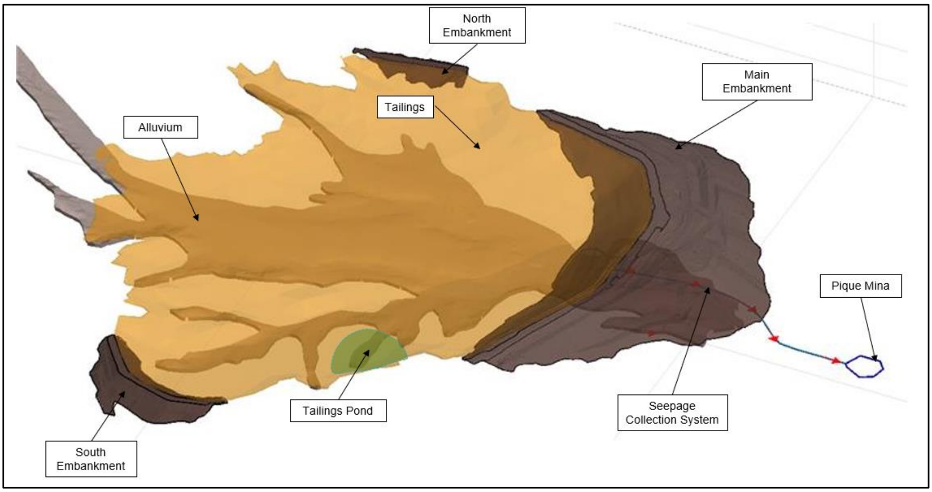

Figure 3. Seepage Collection System – 3D Overview

3 EL BUITRE CLOSURE CAP OVERVIEW

3.1 *Design Objectives*

The proposed EBCC will provide permanent and secure storage of waste rock from mining operations and will be progressively developed in stages. Staged construction of the EBCC has the following objectives:

- Enhance the overall stability and minimize the long-term risks of the Candelaria TSF by further consolidating, densifying, and dewatering the tailings contained within the closed impoundment, thus, increasing the density and reducing the fluidity or flowability of the impounded tailings. A higher density and lower flowability has the potential to reduce the consequences associated with a tailings dam breach and improve tailings behavior during seismic loading (less susceptible to liquefaction).
- Provide additional waste storage capacity to support ongoing mine operations without requiring significant additional site disturbance for a new or expanded dump footprint.
- Provide a waste rock storage area located within a reasonable haul distance from the open pit.

The EBCC final configuration and cross section are illustrated on Figures 4 and 5, respectively. The total mass and placement geometry of waste rock that could potentially be stored over the Candelaria TSF is dependent on the strength, deformability, and drainage characteristics of the underlying tailings, the rate of waste rock placement, and the geotechnical stability of the impoundment embankments. Waste rock will be selectively placed to buttress the accessible northern embankments, and runout from a hypothetical dam breach would be contained within the open pit. The waste rock placement schedule for the cap will allow time for water pore pressures that develop in the underlying tailings to dissipate. The tailings response to surcharge loading is being assessed in the test pad program (see Section 4), in order to demonstrate that foundation stability will be maintained. The EBCC configuration will ensure that runout from a hypothetical failure of the embankment would report to the open pit and thus preclude impact to the public.

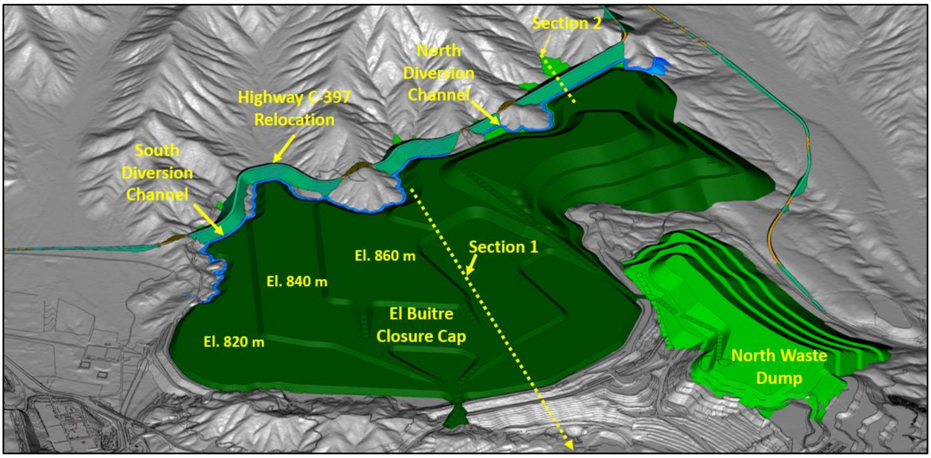

Figure 4. Final Proposed EBCC Arrangement

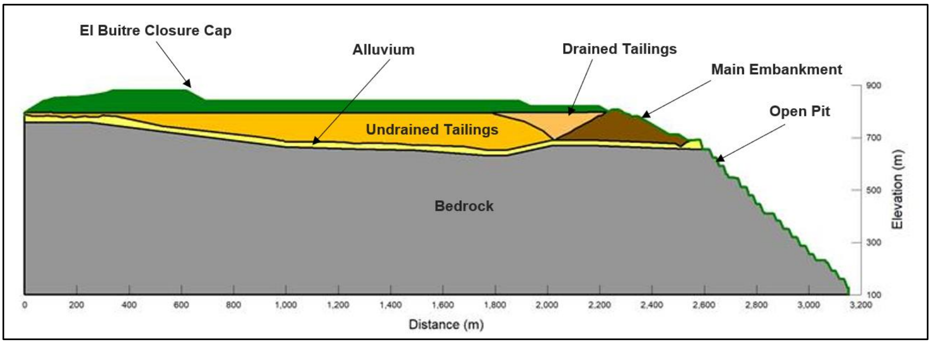

Figure 5. Final Proposed EBCC Cross Section

Pore pressure response in the saturated tailings is expected, and the potential for excess pore pressure development, leading to undrained failure or bearing capacity instability were carefully considered in the trial program. The Pinto Valley tailings impoundment failure provides an example of instability induced by waste dump loading onto a decommissioned tailings impoundment. This incident occurred in 1997 (Hansen and LaFronz, 2000, Adams et al, 2018), during placement of 50 ft. (17 m) thick lifts of waste rock on the tailings surface. The sand dam, which had been developed using the upstream construction method, had a relatively thin zone of drained sandy materials along the face, with saturated fine tailings within the impoundment. Bulging was observed during placement of the second waste rock lift, and the failure resulted when the face of the dam ruptured as the liquefied fine tailings broke through the sandy embankment crust. This failure resulted in the release of tailings and waste rock which flowed viscously downgradient to Pinto Creek located approximately 2,000 ft (610 m) downstream of the impoundment. The failure was directly related to rapid, undrained loading caused by the placement of waste rock over the saturated tailings (Adams et al, 2018).

The overall stability of the EBCC closure cap will be maintained by staged loading of waste rock layers. It is anticipated that pore pressures will increase in the underlying saturated fine-grained tailings, and then dissipate adequately prior to placement of subsequent waste rock layers. Instrumentation systems will include several piezometers installed within the tailings mass, and these will be used to monitor pore pressure development and dissipation throughout the waste rock loading cycles. The pore pressure monitoring will be utilized to control the waste rock loading sequence and is anticipated to be most useful for establishing the layer thicknesses and loading sequence during the first layers of waste rock placement. It is anticipated that the pore pressure response in the tailings will become muted as the waste rock stack gets higher and the underlying tailings become more drained and compressed.

3.2 *Configuration Requirements*

The proposed EBCC will be constructed over the Candelaria TSF, and also within the area directly to the north of the TSF. The EBCC will initially be developed using shallow terraced geometry to facilitate the loading sequence, in order to maintain the trafficability and stability of the capping layers. Permitted tailings surface and embankment crest elevations are 798.5 m and are 800 m, respectively. The EBCC will be constructed to El. 860 m in three stages, with additional waste rock placed to El. 940 m along the north side of the North Embankment (adjacent to the Candelaria TSF footprint). The tailings surface will initially be capped with 4 m of waste rock followed by placement of subsequent layers ranging in thickness from 5 to 15 m. The EBCC will be constructed at a flat overall benched slope of 20H:1V up to El. 860 m.

The toe of the final benches will encroach on the adjacent Highway C-397, which will be relocated prior to and during the initial capping stage of the EBCC and will extend along the west side of the facility. A haul truck access ramp will be constructed on the northern edge of the Candelaria TSF near the North Embankment.

The main components of the Candelaria TSF include a free draining Main Embankment and two saddle dams (North and South). The Main Embankment is located along the east side of the facility and separates the TSF from the Open Pit and the North Waste Dump. The South and North Embankments are located in topographical low points along the south and north sides of the TSF. The North embankment will be buttressed by the EBCC waste rock storage areas, whereas the Main and South embankments will be largely unaffected during development of the EBCC.

Stability analyses indicate that the Main and South embankments will remain stable following construction of the proposed EBCC and exceeds local and international factor of safety requirements for static, seismic (pseudo-static) and post-earthquake conditions. Preliminary tailings consolidation analyses have been conducted to estimate the expected tailings consolidation seepage volumes generated by the waste rock loading.

3.3 *Water Management*

The configuration of the proposed EBCC will create a mounded landform with drainage towards the perimeter of the TSF. Stormwater runoff from the western catchment area will be directed by culverts under Highway C-397, and then routed around the perimeter of the EBCC via diversion channels. The channels will include North and South Diversion Channels, which drain to the north and south respectively, and discharge to existing drainage features beyond the extent of the EBCC. Waste rock fill will be placed on the west side of the relocated highway to avoid pooling and to allow the upper catchments to drain into the diversion channels.

4 SITE WORK

4.1 *Site Investigations*

Numerous site investigations have been conducted at the Candelaria TSF over the years. Historical SI programs (in 2009, 2011 and 2014) have mostly consisted of cone penetration testing (CPT), Seismic CPT (SCPT), sonic drilling, and Vibrating Wire Piezometer (VWP) installations. Historical SCPT data collected in 2009 and 2014 have been compared to the 2018 and 2019 SCPT data to analyze the impact of subsequent tailings deposition on the stiffness and state of the tailings.

The detailed design of the EBCC will rely on information collected during construction of two waste rock test pads and a two-phase site investigation (SI) program. To date the 2019 Phase 1 SI program has defined the baseline geotechnical and hydrogeological conditions for the tailings contained within the deactivated Candelaria TSF. The 2020 Phase 2 SI program (in progress) will evaluate the densification and foundation improvements that result after loading at each of the two test pad sites.

The interlayered tailings at the Candelaria TSF can be separated into two general material types: (1) sandy tailings and (2) fine-grained tailings. Sandy tailings have been deposited adjacent to the embankments and along the impoundment perimeter where tailings spigots have been situated. Fine-grained tailings slimes tended to accumulate near the supernatant pond area, farther from the discharge spigots. Tailings adjacent to the embankments are generally coarser than tailings at Test Pad 1, and tailings below the supernatant pond would be expected to be somewhat finer than tailings at Test Pad 2. The approximate extent of fine-grained tailings, with respect to the test pad areas and embankments, is shown on Figure 6.

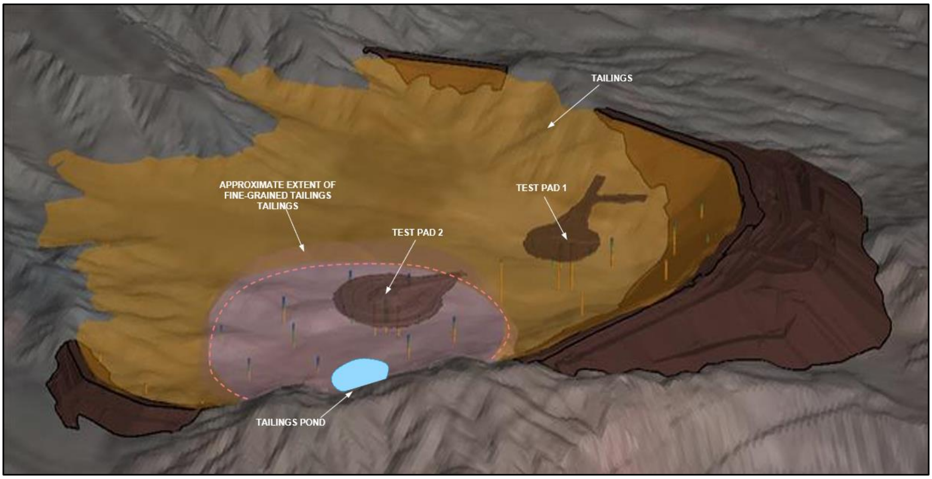

Figure 6. Tailings Distribution Overview

The 2019 Phase 1 SI program investigated the Test Pads 1 and 2 areas, and the tailings located at the upstream side of the Main Embankment and South Embankment. The SI program included 12 sonic geotechnical drillholes with Lexan/Shelby tube sampling, 11 SCPT, tailings sampling for geotechnical and rheological testing, electronic vane shear testing (VST) and installation of 60 VWPs. The SCPT soundings included pore pressure dissipation (PPD) tests at selected depth intervals, as well as compression wave (P-wave) and shear wave (S-wave) measurements.

Laboratory testing (rheology and index testing) of the tailings was conducted during Q1 2020. Supplementary laboratory testing to determine the Critical State Line (CSL) and deformation/strength characteristics of the tailings is currently in-progress. The tailings state and strength parameters interpretation will be refined to include the laboratory testing results.

4.2 *Data Interpretation*

4.2.1 *Tailings Characterization*

Tailings samples collected at the two test pad areas were found to contain silt and sand mixtures (fines contents varying from 36% to 94%) with an average specific gravity of approximately 3.0. Particle size distribution (PSD) results indicate interlayering of fine-grained with coarse-grained tailings at both test pad locations. The range of values obtained for Atterberg Limits was consistent between both test pad locations. Samples tested were found to be non-plastic to slightly plastic (PI < 4) and with measured Liquid Limits in the range of 16 to 20. Moisture contents relative to the estimated Liquid Limits indicate the tailings become less flowable with rheological characteristics that can be described as paste-like to soil-like.

The SCPT probes indicate that the tailings are generally contractive and saturated at depth. The data indicate that sandy tailings near the embankments have lower state parameters (less contractive) than those located at the test pad locations. Tailings upstream of the Main Embankment become slightly dilative below depths of approximately 50 m.

The comparison with historical SCPT (2009 and 2014 with 2019, and recently with 2020) data suggests an increase in stiffness and reduction in brittleness, as the tailings become denser (less contractive) due to the additional loading from tailings deposition and/or the fill loadings at the trial pads. CPT data obtainedfor the foundation tailings, both before and after Test Pad 2 loading, confirmed a general reduction in the state parameter and an increase in the normalized cone resistance (Q_{tn}), as shown on Figure 7. The undrained strength of the in-situ tailings increased significantly due to consolidation from test pad construction.

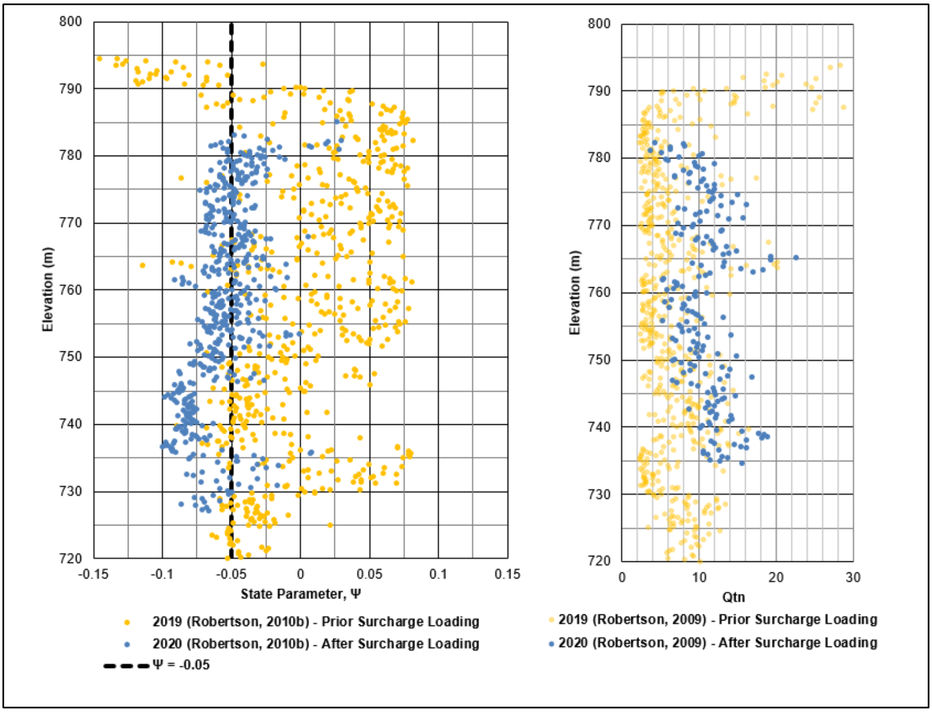

Figure 7. CPT Data Interpretation Before (2019) and After (2020) Test Pad 2 Construction

4.2.2 *Pore Pressure Conditions*

The PPD data recorded in the tailings deposit shows that pore pressure conditions are below hydrostatic, which indicates that the underlying alluvium contributes to an effective underdrainage system. VWP measurements at the embankments and test pad areas indicate that the tailings are continuing to drain. Piezometers adjacent to the Test Pad 1 area indicate that the phreatic surface is steadily dropping at a rate of about 0.5 m per month. The pore pressure data near the embankments indicate drained, partially saturated conditions within the upper 20 to 30 m of tailings, where drainage is further enhanced by the coarser tailings sands, and the adjacent free draining rockfill materials in the embankment.

4.3 *Trial Program*

4.3.1 *General*

Information collected during the development of the test pad program allows for tailings parameters and geotechnical analyses to be updated and calibrated and facilitates the determination of appropriate waste rock loading rates. The overall construction sequence/configuration and water management plan for the EBCC will also be refined on the basis of this updated information. Test Pad 2 has been constructed on more compressible finer grained slimes tailings (Pond Tailings), and Test Pad 1 on more sandy beach tailings (Beach Tailings). Field monitoring results will also facilitate updating estimates of tailings settlements and consolidation seepage during development of the proposed EBCC. Figure 8 shows an overview of the trial program as of August 2020.

4.3.2 *Test Pad 2 (Pond Tailings)*

Construction of Test Pad 2 started on September 2019 and was completed by mid-January 2020. It was constructed by placing 2 to 3 m thick lifts to its final height of 30 m. A total of approximately 3.1 million tonnes of waste rock material was placed on Test Pad 2, at an average rate of approximately 26,000 tonnes per day. The original test pad configuration allowed for 5H:1V slopes along with a 45 m diameter crest. During construction, the test pad geometry was revised to incorporate a broader 70 m diameter crest to allow the continued use of CAT 793 haul trucks for the upper lifts. Steeper test pad side slopes of 2H:1V were also incorporated into the design to accelerate the schedule and reduce waste rock quantities.

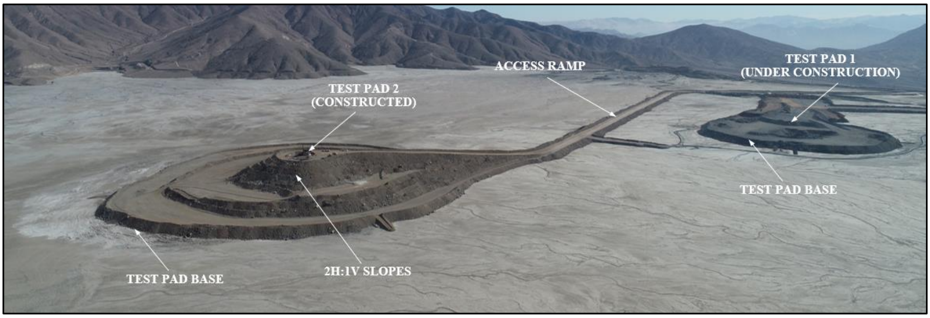

Figure 8. Trial Program Overview (As of August 2020)

The tailings response to the surcharge loading was carefully monitored during construction with detailed visual monitoring, settlement measurements plus pore pressure response at various locations and depths within the foundation tailings. Monitoring instrumentation at Test Pad 2 included 26 VWPs, four (4) settlement plates and four (4) survey monuments. The central piezometers were lost during construction of the upper lifts, due to large consolidation settlements. Ongoing pore pressure monitoring continued using the VWPs installed at the base of the 2H:1V conical load.

Pore pressures increased during loading as expected, with relatively rapid incremental responses observed for each construction lift. Excess pore pressures have continuously dissipated, since construction was completed in January 2020, at an average dissipation rate of about 5 kPa/day. Excess pore water pressures fully disipated two months later after construction ended.

Settlement plates show the greatest settlements below the center of the pad, which is consistent with the higher loading conditions. Foundation settlements of up to 6.0 m have been recorded to date. The rate of settlement has slowly decreased with time, as the excess pore pressure continues to dissipate. An average initial settlement of about 2 m occurred before detailed settlement plate readings commenced. Some of this vertical displacement was associated with lateral displacement of saturated near-surface tailings, as indicated by the development of bulging or ‘waves’ in the tailings during placement of the initial waste rock layer. The estimated settlement prior to the installation varies within the test pad footprint, with larger settlements observed in finer tailings at the south side of the pad near the supernatant pond area.

The latest monitoring data, from the remaining VWPs at Test Pad 2, indicate that excess pore pressures generated during pad construction have completely dissipated. The phreatic level at these locations has continued to drop below pre-loading levels. Tailings pore pressure profiles for Test Pad 2 are shown on Figure 9.

4.3.3 *Test Pad 1 (Beach Tailings)*

Construction of Test Pad 1 started in May 2020. It will include a 70 m diameter crest, slopes at 2.0H:1.0V and will be raised to a height of 30 m above the tailings surface. A 6 m thick test pad base platform is currently under construction to develop a suitable buttress. CAT 793 haul trucks will continue to be used for the construction. Test Pad 1 is constructed on sandy beach tailings and was observed to experience less foundation response during surcharge loading in comparison with Test Pad 2. Figure 10 shows the construction of the test pad base.

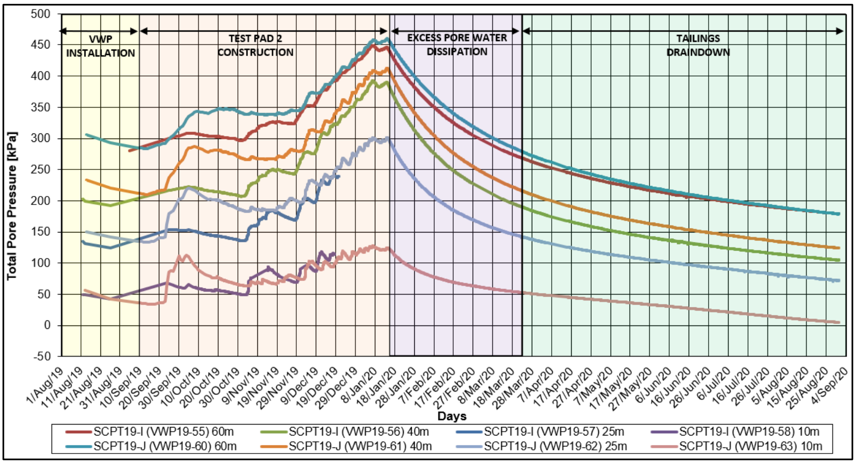

Figure 9. VWP Measurements near the Center of Test Pad 2

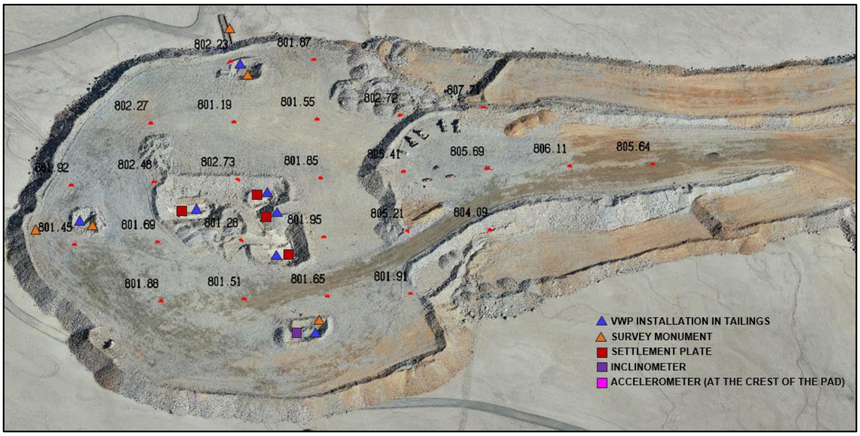

Figure 10. Test Pad 1 Construction (As of August 2020)

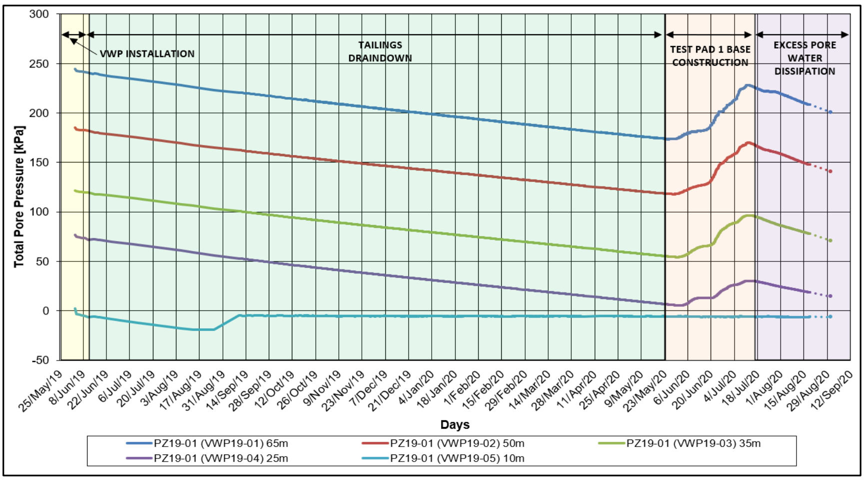

Figure 11. VWP Measurements at the Center of Test Pad 1

The sandy beach tailings located within the Test Pad 1 footprint are relatively coarser grained, and a significant drained and unsaturated zone has already been established within the upper 10 m. Very little response was observed in these materials during construction of the access roads or the test pad base (Lift 1). Monitoring data also indicates that desaturation of the upper tailings is ongoing.

Pore pressure measurements at Test Pad 1 show that the phreatic surface has dropped approximately 5 m since monitoring was started in June 2019. The data indicates unsaturated conditions are generally present in approximately the upper 10 m of tailings. Pore pressure profiles at the center of the Test Pad 1 are shown on Figure 11. Test Pad 1 is expected to be fully constructed during Q3 2020.

5 SUMMARY

There are significant opportunities to integrate the waste rock disposal sites with the development of a thicker closure cap on top of the decommissioned Candelaria TSF. This integrated waste management strategy, which is named the EBCC, will result in the development of a stable post closure landform that, in combination with contingency containment in the open pit, virtually eliminates risk to the public and downstream communities.

The proposed EBCC also provides an opportunity to simplify the storm water management systems during operations and particularly for the post closure site arrangement, by incorporating suitable drainage and diversions along the upslope portion of the EBCC. Storm water drainage to be routed around the facility, thus removing the potential for stormwater pooling on the capped impoundment and the need for an overflow spillway after closure. The EBCC will be integrated with the realignment of Highway C-397 to provide appropriate storm water management, as the upslope catchment areas will be diverted around the facility through drainage swales.

The development of the proposed EBCC will enhance the physical stability of the tailings impoundment and will provide permanent and secure storage of waste rock derived from ongoing mine operations. The EBCC will be constructed both on the Candelaria TSF, and within the area directly to the north of the TSF.

The EBCC will initially be developed using shallow terraced geometry to facilitate the loading sequence, in order to maintain the trafficability and stability of the capping layers. It will be developed in stages to allow enough time for consolidation and stabilization of the underlying tailings. It is anticipated that pore pressures will be generated in the saturated fine-grained tailings materials, but these excess pore pressures will dissipate adequately prior to placement of subsequent waste rock layers. As the tailings are progressively compressed and drained with the development of the EBCC, the overall stability of the Candelaria TSF will be enhanced. The overall slope of the waste rock pile will be maintained at approximately 20H:1V during operations to provide a stable and robust arrangement.

Consolidation of the tailings mass will also result in a reduced void ratio with a corresponding reduction in the moisture content of the densified tailings. The potential fluidity of remoulded tailings (due to liquefaction) will be reduced significantly as the moisture content is reduced below the Liquid Limit. The dense and more plastic nature of the densified tailings will reduce the potential consequences of a hypothetical tailings release from an assumed post-closure breach.

Detailed design of the EBCC will rely on information collected during construction of Test Pads 1 and 2, in conjunction with a two-phase SI program. Test Pad 2 was completed by mid-January 2020 and incorporated 2 to 3 m thick lifts to its final height of 30 m. Foundation tailings pore pressures increased during loading as expected, with relatively rapid incremental responses observed for each construction lift. The sandy beach tailings located within the Test Pad 1 footprint are coarser and a significant drained and unsaturated zone had developed within the upper 10 m prior to commencing pad loading. Very little response was observed in these materials during construction of the access roads or the test pad base (Lift 1). Monitoring data also indicates that desaturation of the upper tailings is ongoing. Test Pad 1 is expected to be fully constructed by Q3 2020.

The Phase 2 SI program will evaluate the densification and tailings foundation improvements that result after loading at each of the two test pad sites. In-situ testing and laboratory testing of the tailings will be performed to estimate the changes in density and moisture content within the tailings. The results of the Phase 2 SI, laboratory testing and monitoring programs will be used to update the tailings characterization and geotechnical analysis conducted to date, as well as to conduct dam breach modelling, seismic response and deformation analyses of the Candelaria TSF and EBCC and review the interaction of the open pit with the Candelaria TSF Main Embankment.

Construction of the EBCC will provide storage for waste rock generated from ongoing mining operations. The placement of waste rock is expected to densify and further dewater the tailings, increasing the solids content and reducing the potential fluidity (flowability) of the tailings. This will reduce the overall risk of the facility by reducing the potential consequences of a post-closure dam failure event, as the tailings will be significantly less flowable. This integrated waste management strategy for the Candelaria Mine will provide operational benefits for ongoing waste rock management while concurrently stabilizing the impounded tailings to reduce the long term risks, and to enhance the reclamation objectives for the mine site.

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