Affiliates of our company currently operate 18 tailings storage facilities (TSFs), 16 in the U.S. and two in Peru, and manage 59 in the U.S. that are inactive or reclaimed. Our inventory of TSFs comprises 13 active and 53 inactive or reclaimed facilities with an upstream design, five active and five inactive with a centerline design, and one reclaimed facility with a downstream design. After a detailed review of corporate records, we have recently increased the number of reported facilities to account for legacy operations that were reclaimed several decades ago.

We recognize that the failure of tailings and other impoundments at any of our mining operations could cause severe – and in some cases catastrophic – property and environmental damage and loss of life. Many of our tailings impoundments are located in areas where a failure has the potential to impact individual dwellings, and a limited number of impoundments are in areas where a failure has the potential to impact nearby communities or mining infrastructure. As a result, our programs take into account the significant consequences resulting from a potential failure, and we apply substantial financial resources and technical resources, both internal and external, to materially reduce the likelihood of failures.

Our Tailings Management and Stewardship Program was launched in 2004 and has evolved significantly over the last 15 years. Today, through the Program, we employ substantial engineering expertise, technological monitoring, and local and corporate management oversight to validate these facilities are designed, built, operated and monitored to minimize risk to employees, neighboring communities and the environment. These safeguards generally fall within four categories: (1) engineering and design; (2) rigorous adherence to construction and operational parameters through monitoring; (3) multi-tiered oversight; and (4) adherence to practices grounded in continuous improvement and learning from past experiences, including industry failures.

We also implement the core elements from International Council on Mining and Metals Position Statement on Preventing Catastrophic Failure of Tailings Storage Facilities published in December 2016: accountability, responsibility and competency; planning and resourcing; risk management; change management; emergency preparedness and response; and review and assurance.

We have a strong commitment from our Board of Directors and executive management team to provide the necessary resources to protect safety. While we believe our Tailings Management and Stewardship Program is robust and mitigates risks, we continue to identify opportunities for continuous improvement in all aspects of our Program. Our corporate culture is to communicate critical information upward so that important matters are identified, evaluated and acted upon.

Unique Aspects of Tailings Dams

In 2018, we produced approximately 324 million tons of tailings and 371 million metric tons of waste rock. TSFs are uniquely engineered structures, with embankments often constructed from the tailings material itself. TSFs have two primary purposes: to store the tailings in perpetuity and to reclaim as much water as possible to be reused in the metallurgical extraction process. Unlike water dams, which are designed and built to their ultimate capacity before any water is placed in the adjoining reservoir, tailings dams are constructed as the reservoir is filled over the life cycle of the mine, so that the facility is constructed and filled at the same time, generally taking many years to reach completion. The primary risks associated with managing tailings relate to structural stability, water balance, geochemistry, water quality and dust generation.

In October 2018, ICMM’s Council of CEOs approved an aspirational goal for tailings: “We agree to work collectively to advance progress over the next 10-15 years toward developing superior and cost-effective alternatives to conventional wet tailings storage facilities.” Objectives associated with the aspirational goal include identifying alternative methods of mineral recovery to significantly reduce and/or eliminate the generation of tailings waste as well as promoting development of technologies to remove moisture from tailings. We will continue to work with our industry peers on these ambitions, with a particular focus on the inherently significant challenge around scalability of solutions for our large-scale operations. For example, our Cerro Verde concentrator operates throughputs over 400,000 metric tons per day, and we operate several mills with capacities exceeding 100,000 metric tons per day.
Engineering Design and Construction

Within our portfolio, we have current extensions to designs that were started decades ago, and we have new tailings facility designs at Morenci in Arizona. Dam designs are based on criteria that take into account earthquake and rainfall potential, soil and rock foundation conditions, and the specific nature, volume and rate of production of the tailings material to be stored at a given site. Criteria are selected to minimize risks of all feasible failure modes.

Our active mining operations have on-site, full-time, dedicated engineers who oversee the specialized work required for this unique operations area. Those site specialists confer regularly with one another, with technical specialists at our corporate headquarters and with outside experts at leading international engineering consulting firms during all phases of our TSFs’ lives. Operations personnel at each site are required to adhere to the strict parameters set forth in the design process, which the Engineer of Record (EoR) may update periodically, during ongoing construction with rise of the structure over its life.

Site engineers provide monthly reports to each site General Manager regarding the status of multiple key performance indicators (KPIs); this information is shared with corporate executive leadership each quarter. KPIs are used to identify TSF conditions that may eventually lead to dam safety risks, so that necessary operational changes are identified and mitigation actions are proactively taken. KPI scoring criteria (thresholds) are established by our EoR to control against potential failure modes. Our Dashboard Reports group KPIs into four main categories including automated stability monitoring, reclaim pond management/water management, proper dam construction/maintenance and third-party action item tracking.

The following table includes a selection of KPI sub-categories and associated potential failure modes:

<table>
<thead>
<tr>
<th>Category / Sub Category</th>
<th>Potential Failure Modes / Risks Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category: Automated Stability Monitoring</strong></td>
<td></td>
</tr>
<tr>
<td>Phreatic Surface</td>
<td>Instability due to increased pore pressure</td>
</tr>
<tr>
<td>Movement</td>
<td>Instability due to foundation or embankment failure, or low strength materials or both</td>
</tr>
<tr>
<td><strong>Category: Reclaim Pond Management</strong></td>
<td></td>
</tr>
<tr>
<td>Tailings Beach Width and Freeboard</td>
<td>Overtopping, instability due to increased pore pressure</td>
</tr>
<tr>
<td><strong>Category: Proper Dam Construction</strong></td>
<td></td>
</tr>
<tr>
<td>Tailings Embankment Material Quality</td>
<td>Instability due to low strength or low permeability materials</td>
</tr>
<tr>
<td>Material Balance/Deposition Plan</td>
<td>Inability to raise dam as required to maintain freeboard and storage Increased pore pressures from rate of loading</td>
</tr>
<tr>
<td>Measured and Visual Seepage Flow Monitoring</td>
<td>Piping, internal erosion, increased pore pressures</td>
</tr>
<tr>
<td>Monitoring and Inspections (EoR, Site Tailings Team)</td>
<td>Construction, operation or maintenance issues, piping, seepage, settlement</td>
</tr>
<tr>
<td><strong>Category: Third-Party Action Item Tracking</strong></td>
<td></td>
</tr>
<tr>
<td>Third-Party Action Item Tracking (TST, TRB)</td>
<td>Timeliness in addressing uncertainties or applying needed mitigations</td>
</tr>
</tbody>
</table>
We retain an EoR for all active sites, and currently have an EoR for our higher-priority inactive sites. Our EoRs are employed by the following companies: AECOM (46 TSFs), Stantec (22 TSFs), Haley & Aldrich (two TSFs), Golder Associates (two TSF study projects), and Klohn Crippen Berger (one TSF study project). The role of EoR is filled by a qualified external engineer, supported by his or her consulting engineering company. EoRs are responsible for reviewing and approving all engineering and design data, associated operating and monitoring procedures, as-built drawings, and facility inspections to confirm physical integrity, safety and performance of the facility and associated structures. This includes the EoR defining parameters and specifications that we use for construction and operations such as dam slope angle, rate of rise, construction and operational material quality and methods, water level (measured as pore pressure) within the dam, and maximum allowable water storage on the surface of the impoundment. We are embarking on a review of our remaining inactive sites to determine whether any warrant an EoR. We recognize that there is a limited supply of suitable EoRs on a global basis, which may become a constraint in the near future.

**Adherence through Monitoring**

Monitoring takes many forms, including the use of piezometers to provide information about water level (pore pressure) conditions within the dam structure. We also monitor the size of the surface water pond and the extent of the “beach” between the outer edges of the pond and the dam crest. We perform construction quality control and assurance through material testing and methods inspections, and we monitor the operational condition of pipes and conveyances with pressure sensors designed to identify pipe breaks or malfunctions through real-time data reporting and control networks. Most of our monitoring instrument data is collected automatically through wireless networks on a frequency that allows for ongoing and automatic comparison to our EoR’s pre-defined thresholds and automatic alarming when thresholds are exceeded. Such alarms notify our engineers and operators of exceedances so that appropriate actions can be taken in a timely manner to keep our TSFs operating within expected ranges. We also use internal movement monitoring equipment (inclinometers) and monitor any anomalous external movement through use of satellite-based radar (InSAR). InSAR provides images that allow us to detect and measure ground displacements across our TSFs. The following includes estimates of InSAR and instrument counts at our TSFs as of 2018.

**Monitoring Instrument Table**

<table>
<thead>
<tr>
<th>TSF Status</th>
<th>TSFs with InSAR</th>
<th>Piezometers</th>
<th>Inclinometers</th>
<th>External Movement Monuments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>17</td>
<td>902</td>
<td>41</td>
<td>30</td>
</tr>
<tr>
<td>Closed/Inactive</td>
<td>28</td>
<td>145</td>
<td>108</td>
<td>6</td>
</tr>
</tbody>
</table>

We continually add instruments to either replace or enhance existing systems. We also use automated Shape Acceleration Arrays, tensiometers and weather stations as well as various methods for accurate repeat surveys of topography and bathymetry. Our InSAR vendor provides data to our site and corporate engineers every one to two weeks (rapid reports) and every quarter (comprehensive reports). We continue to work with our vendors to verify our monitoring data is robust and assessed for accuracy. The most important aspect to monitoring is to have clearly understood thresholds and associated actions.

Trained site engineers conduct inspections of our active tailings storage facilities at least monthly, and our Engineers of Record inspect our operating tailings storage facilities at least quarterly (monthly in some cases).
Multi-Tiered Oversight

Oversight starts with the operational management and engineering teams at our sites. We use an escalating hierarchy of warning levels for parameters that require increased attention to address the conditions that trigger warnings so they are resolved before they become an actual problem. In addition, we have a tailings management team at the corporate level, which serves as a dedicated technical resource for the site operators and engineers as well as an additional layer of oversight. The corporate team does not have day-to-day operating pressures and exists solely to provide oversight of our tailings dams. The corporate team communicates its activities and any findings directly to senior corporate management, which maintains active involvement and oversight with respect to our company’s tailings management and stewardship.

Our tailings stewardship team, comprising third-party engineers and internal experts, physically inspects all of our tailings facilities, reviews associated documents and monitoring data to identify potentially significant deficiencies, and recommends corrective actions. In addition, we have commissioned Technical Review Boards (generally four-person panels comprising internationally known experts, typically PhDs with more than 30 years of experience in their respective areas of specialization). These boards provide independent opinions and guidance on the physical integrity, safety and performance of our tailings storage facilities and associated management systems. Each Technical Review Board for operating sites has direct access to the Chief Operating Officer and direct access to the Vice President-Environmental Services and Sustainable Development for inactive/legacy sites, and each member has a responsibility to report any concerns not being adequately addressed by line management.

Our tailings stewardship team has inspected all active tailings storage facilities within the past 12 months and has visited almost all facilities within the past three years. Members of our Technical Review Boards visit our active and select inactive tailings storage facilities at least every four years and meet with our internal teams and EoRs periodically to review our follow-up activities to their previous recommendations. We track recommended actions from inception to completion.

Remediating Findings / Improving Practices

Since the Mount Polley tailings dam failure in 2014 and the Samarco tailings dam failure in 2015, our Technical Review Boards have recommended that our sites and Engineers of Record investigate and identify site conditions that could create a potential failure. The company then deploys resources to remediate findings. For example, in 2018, we acted on the recommendations of TRBs and, out of an abundance of caution, we initiated construction on tailings dam buttress projects at both Sierrita and Henderson.

Case Studies

Sierrita Buttress Project

Our Sierrita mine is an open-pit copper and molybdenum mining complex that has been in operation since 1959. It is located approximately 20 miles southwest of Tucson, Ariz., and 7 miles west of the town of Green Valley. Like all of our TSFs, the Sierrita tailings impoundment (STI) is engineered, constructed and monitored for structural stability.

In 2014, as part of a scheduled, comprehensive geotechnical investigation, Sierrita’s Engineer of Record (EoR) from an international consulting firm with geotechnical tailings expertise identified a localized layer (between 1 and 13 feet thick) of lower resistance, partially saturated material. This layer is located at the original ground surface under up to several hundred feet of partially saturated material near the south slope. Although this low resistance layer could be more prone to movement than the surrounding material, the 2014 findings did not indicate a safety issue. The lower resistance layer was small and confined, and based on piezometer readings (a sensing device that measures water levels) and all our other data at the time, the STI satisfied all of our safety factors.

In 2017, as part of our ongoing monitoring program, we detected modest data changes in the aforementioned area identified in 2014. Our internal technical team, the EoR and the Tailings Review Board all concluded these data changes warranted further analysis, so we initiated a focused investigation. As part of that process, we installed additional sensing devices and conducted additional analyses, and our EoR began inspecting the STI monthly.

The resulting data suggested that under the most conservative, reasonable assumptions, the layer of lower resistance material could lead to a localized slope instability. Although our internal and external experts have all confirmed that
the STI is stable, it was possible that the condition could deteriorate over time and result in a localized movement of a limited amount of tailings material. Our EoR advised us that the reasonable worst-case scenario was that the material could move less than 100 yards south beyond the toe and would not otherwise jeopardize containment. Further, the EoR recommended, and the Tailings Review Board concurred, that a stabilizing buttress be constructed to mitigate risk.

The day after receiving the Engineer of Record report recommendation, senior executives met with the Arizona Department of Environmental Quality to seek regulatory concurrence to construct a precautionary buttress in an expedient manner. Phase one construction of a buttress on the southern stretch of the STI commenced with initial agency approval, and we have started Phase II construction work to enlarge the buttress.

Sierrita engineers continue to closely monitor the STI water balance and report against EoR established thresholds in monthly and quarterly Dashboard reports to senior management.

**Henderson Buttress Project**

Our Henderson molybdenum mine has been in operation since 1976 and is located 42 miles west of Denver, Colo. Henderson’s TSF includes two dams.

In 2014, Henderson’s Engineer of Record (EoR) proposed a plan to fill data gaps identified during Henderson’s first Tailings Review Board (TRB) meeting. The TRB concurred that geotechnical investigations should be conducted in multiple areas of the embankment to confirm tailings and foundation material properties and the extent/thickness of saturated materials. The EoR conducted the field investigation and subsequent laboratory program in 2015. A thin layer of saturated tailings was identified at multiple areas along the embankment, and an initial stability analysis was conducted in 2016. A follow-up investigation was done in 2016 to augment the initial work and address actions identified by the TRB. The stability evaluation was updated to reflect both undrained static loading conditions and the 10,000-year event post-earthquake loading conditions. The Henderson dams are permitted at the 2,500-year and 5,000-year earthquake, but the EoR further assessed stability for the 10,000-year earthquake per recommendation of the TRB.

The results of the stability analysis showed that the modifications to the embankment in one area will be necessary to meet internal seismic design criteria (factor of safety) for future crest elevations. Buttressing this area was found to be the most practical and effective solution. Construction began in 2018 and will be completed in four stages. Each buttress stage will be constructed on a schedule such that factors of safety requirements are continually met as the embankment is raised.

**Bisbee Tailings Case Study**

After eight years of capping and reclaiming approximately 4,500 acres of inactive tailings impoundments at our Tyrone and Chino mines in New Mexico, Freeport’s Closure and Reclamation team turned its attention to reclaiming 908 acres of inactive tailings impoundments at our legacy Bisbee, Ariz. mine. The tailings facility had been inactive since 1975, and the site staff had been managing mine-impacted waters by storing them in the former open pit and on top of the former tailings impoundments.

The design approach for the Bisbee tailings impoundments was to pond stormwater on top of the tailings impoundments and then allow the water to flow off the top surface in a controlled manner. This design represents a pilot test for stormwater management, as our New Mexico designs required a significant amount of fill to regrade the top surface for positive drainage off the facilities. In addition, those designs directed stormwater flows into channels and down drains that increased in size as the flows aggregated in confluence points.

At Bisbee, the North and South impoundments were reclaimed with engineering controls designed for the 100-year, 24-hour storm event (design storm) which includes a maximum intensity event (100-year, six-hour SCS Type 2 event). Basins on top of the impoundments were sized and lined to hold ponded water from storm events and then attenuate stormwater flow through outlet weirs. The intent of the attenuation design is to temporarily store stormwater within the lined basins until it is bled-off through the free-draining rock outlet weirs positioned at the downstream extents of the North and South impoundments. Stormwater discharge from the top surface rock weirs and from lateral channels along the impoundment side slopes is conveyed to articulated concrete block (ACB)-lined down drains that direct all stormwater off of the impoundments. This configuration results in manageable flows and velocities in the down drains, which represents a way of safely directing stormwater into adjacent drainages. (Some of these drainages have not seen stormwater flows for decades due to the mine operations and could erode if massive flows were directed into these
Our Closure and Reclamation team monitors the performance of the closure design (water infiltration through the cap, upward wicking of salts through the cap, moisture content of the tailings material, soil erosion, plant density and diversity) and also performs maintenance work as needed for the drainage channels, down drains and adjacent drainages receiving stormwater flows.

In 2017, we evaluated the viability of this design for a probable maximum precipitation event. The study concluded that the attenuation basins would fill to a point where the water capacity would extend off the lined area for a short period of time until the attenuated flow off the dam reached equilibrium with designed discharge capacity. In addition, the analysis showed that the ACB in the down drains would remain stable under these conditions. This unique tailings reclamation design has held up during back to back 100-year, 24-hour storms in 2013 with no stability or material erosion issues.

**Tailings System 15-Year Evolution: A Commitment to No Failures**

Our Tailings Management and Stewardship Program was launched in 2004, highlighted by the creation of our first external review board for the Enlozada tailings facility at Cerro Verde near Arequipa, Peru. The creation of this board was a commitment made to the Government of Peru given the size of the Enlozada facility. Initiation of a large-scale tailings reclamation program in New Mexico also began at the time of the program launch. The Tailings Stewardship Team began doing inspections at our TSFs over the next four years to inventory existing conditions and recommend initial steps toward good practice. At the Chino and Tyrone inactive tailings facilities, our reclamation efforts included re-sloping and contouring areas, ensuring drainage channels divert stormwater (assuming 100-year, 24-hour storm events) and limit percolation, establishing points for stormwater to discharge into existing drainages, capping with soil and reseeding with native plants to encourage wildlife habitat.

PTFI launched its Tailings Review Board at the end of 2007. We created a dedicated corporate tailings and water corporate group in 2008. With increased focus by 2008, mitigations recommended by the Tailings Stewardship Team in the Americas were actioned for priority tailings risks. We began providing stewardship training regularly to teams associated with tailings stewardship at both operations and corporate. Beginning in 2012, the program was enhanced to include third-party Tailings Stewardship Team reviewers and site-specific tailings engineers. The large-scale tailings reclamation work in New Mexico was materially completed in 2012.

In 2014, we completed the Bisbee tailings dam reclamation that included lined attenuation basins on top of the surface to throttle stormwater discharges into drainage areas. During the year, team members were implementing standardized procedures for monitoring and applying formalized critical controls. Independent TRBs became a key oversight in the United States, and by 2016, all active sites had established TRBs. Through the TRB process and other studies, any active TSFs not already designed for the Probable Maximum Flood (PMF) were being analyzed to confirm they will not experience a catastrophic failure under a PMF.

In 2017, KPI Dashboard reporting was implemented (e.g. pore pressure and deformation, pond freeboard and beach length, embankment material, and action completion). Additionally, an overhaul to program documentation and improvements to the management of change process were completed, and inactive sites initiated the TRB process.

During 2018, we further enhanced our tailings governance and management systems, including mobile inspection applications, emergency response plan table tops, and systems guides for assigned tailings operations and assurance. Core elements of our program illustrate a clear integration among multiple departments within Freeport-McMoRan for tailings management, including Processing, Engineering, Environment, Land and Water, Health and Safety, Mining, and Tech Services.
Recent Program Enhancements
During 2018, we have:

- Completed our Tailings Management System Guide umbrella document that ties together our numerous tailings management and stewardship programs and procedures, documentation, and personnel roles and responsibilities.
- Continued development of the risk-informed decision-making process and screening design criteria and completed a gap analysis on available information for all TSFs, particularly for inactive and closed TSFs that were previously considered lower priority.
- Completed an emergency action plan tabletop exercise with internal technical and crisis management personnel for one site and established plans for three additional sites’ tabletops in 2019.
- Continued to enhance surveillance and monitoring tools such as developing a mobile data acquisition system tool for field inspections and other key performance indicator data collection activities.
- Continued to improve interpretation and utilization of InSAR data as well as enhance audits of our automated instrument data acquisition, visualization and alarming system.
- Continued to improve water balance modeling by incorporating updated regional extreme precipitation studies, analyzing evaporation rate data from various remote sensing techniques and incorporating methods to better quantify uncertainty in the models.
- Delivered three weeks of high quality technical training courses and workshops for tailings engineers on geotechnical design of levees, tailings deposition modeling, tailings material characterization and laboratory visits, critical state soil mechanics, good practice examples for site engineer functions, and automated data acquisition system maintenance. There was regular information sharing between corporate and site tailings engineers on good practices and implementation of new initiatives.

Controlled Riverine Tailings Management
PTFI’s controlled riverine tailings management system is implemented based on methods approved and permitted by the Government of Indonesia. The site-specific system, chosen after extensive evaluations of over a dozen alternatives, uses an unnavigable river to transport tailings out of the highlands (from approximately 3,000 meters elevation) to an engineered deposition area in the lowlands referred to as the ModADA. The river is not used for potable water, agriculture, fishing or other domestic or commercial uses, nor was it used for these purposes before operations began. Levees have been and continue to be constructed to laterally contain the footprint of the tailings and natural sediment within the ModADA while quantities of finer tailings and other sediments deposit in the estuary and the sea. Independent, environmental management expert audits have reaffirmed the controlled riverine tailings management system is the best site-specific management alternative considering the topographical, seismic and geotechnical, geological, climatological and environmental conditions of the project area. If any conventional tailings system had been selected and implemented, it likely would have structurally failed by now.

In addition to internal and external audits and assessments, PTFI uses the ModADA Management Board (MMB) for oversight of the tailings system. The MMB is a multi-disciplinary expert panel that meets on site to assess system performance and risks associated with the ModADA and coastal zone area. The MMB focuses on the structural integrity of the levees and the geochemical stability of the deposition area as well as associated stakeholder engagement. The MMB provides recommendations to PTFI leadership and engineering teams on priority activities and tracks progress on detailed recommendations.

PTFI’s environmental impacts are well-documented, monitored and managed and have been subject to the Government of Indonesia’s regulatory oversight, including the approval of the AMDAL for PTFI operations and the approval of annual work plans. Impacts of the system, including increases in sedimentation, were predicted in numerous studies and are consistent with the design and operation of the chosen alternative. Monitoring programs have established, except for elevation changes, the environmental impacts of tailings deposition are reversible at the end of mine life.
Data from biological sampling continues to demonstrate that the estuaries downstream of the tailings deposition area are functioning ecosystems, based on both the number of species and the number of specimens collected of nektonic, or free-swimming, organisms such as fish and shrimp. Large-scale demonstration reclamation projects show that several land use options are possible after final closure of the deposition area. When mining is completed, this area can be reclaimed with natural vegetation or used for agriculture, forestry, grazing of livestock and aquaculture among other options, depending on stakeholder ambitions.