Project datasheet Mining

Decommissioning of BSS South Superior Tailings Dam

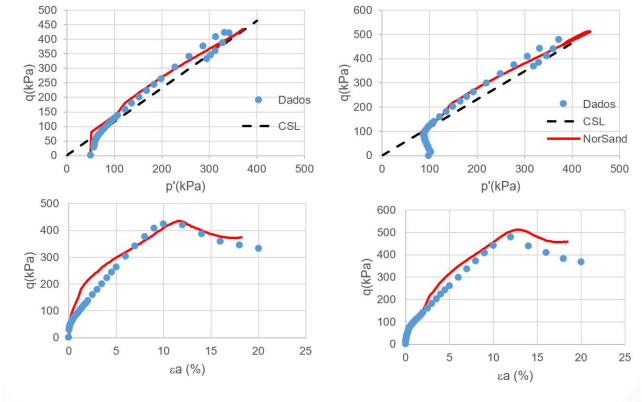
Location: Minas Gerais, Brazil

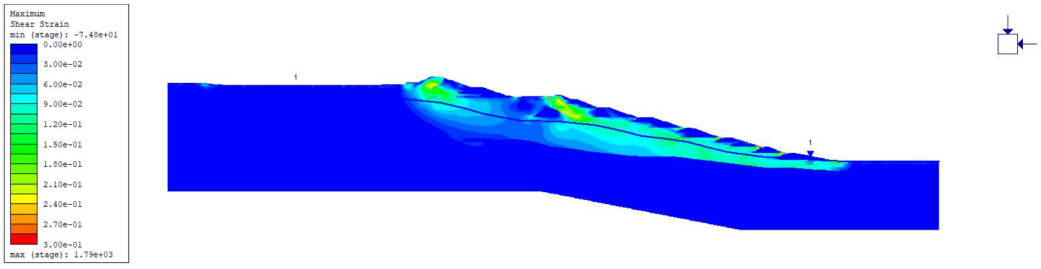
Client: Vale

Description: Terratek carried out in 2020 numerical finite element model to analyse the behaviour of the BSS dam, built by the upstream method and found to present a low factor of safety against static liquefaction. The numerical model using Plaxis employed a UDSM (user-defined soil model) developed by Terratek using the NorSand constitutive model. Therefore, the model is aimed at modelling the tailings behaviour of post-peak loss of strength, or strain-softening

Services provided by Terratek

- Analysis of existing site investigation;
- Obtaining NorSand geotechnical parameters from triaxial test results;
- Modelling the existing dam;
- Numerical modelling of tailings excavation and its effect on the dam behaviour.





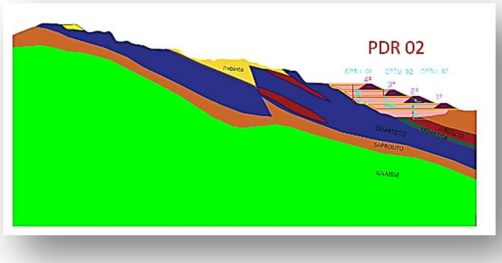
Project datasheet Mining

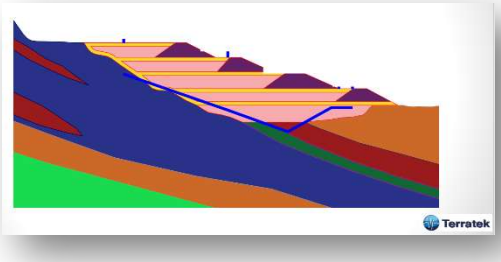
Waste pile design

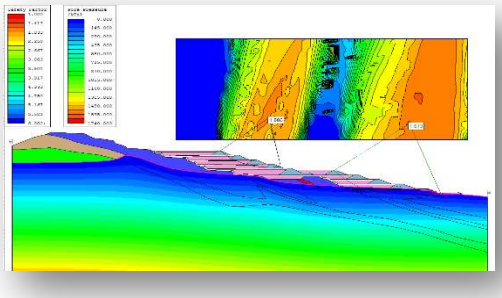
Location: Desterro, MG, Brazil

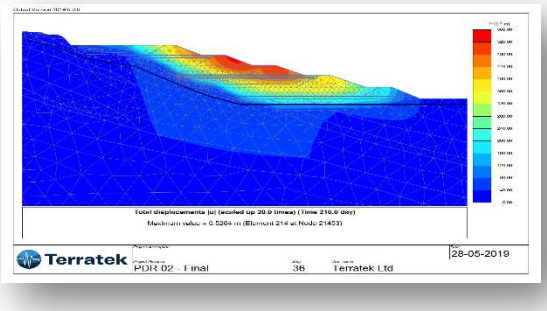
Client: J Mendes Mining

Description: Terratek carried out during 2020 the design of a huge, 80 m high, waste pile on sloping ground. The work included analysis of existing site investigation data, specs for additional site investigation, stability and Plaxis 2D deformation analysis, as well as a proposal for a monitoring programme.









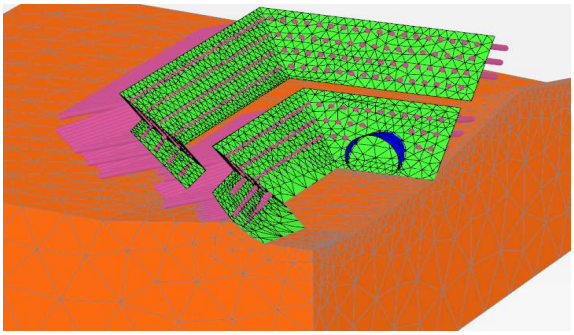
Project datasheet: Underground Mining

Project name: Access Tunnel Design, Bonsucesso Underground Mine

Location: Paracatu, MG, Brazil

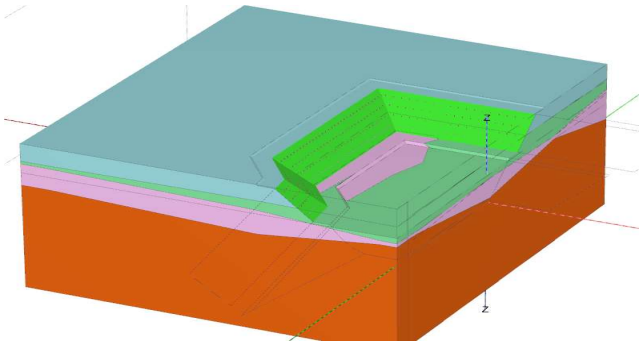
Client: Nexa Resources

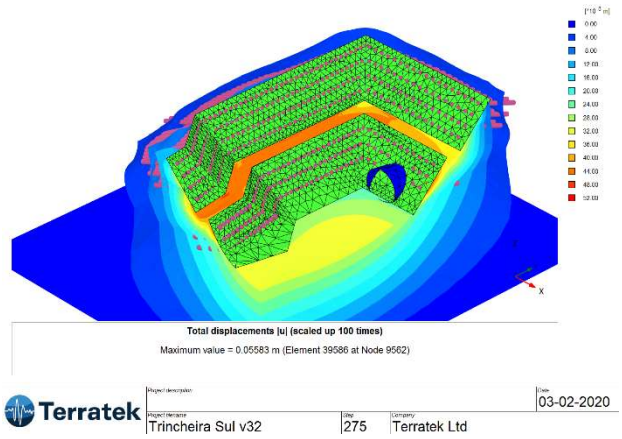
Description: The project consists of the design of two 20 m deep trenches and four tunnels to access the ore. Inside the trench, there are two portals giving access to two tunnels. Each tunnel has a 40 m^2 sectional area. The geotechnical solution for the trenches was soil reinforcement utilizing the soil nailing technique. For the tunnels, the solution was a NATM type solution in which the sandy materials will be stabilised employing horizontal jet-grouting (HJG) columns. Terratek also designed an umbrella-type crown reinforcement with HJG. The tunnel primary lining to be 25 cm thick sprayed concrete. The secondary lining will be 30 cm thick cast in situ concrete.

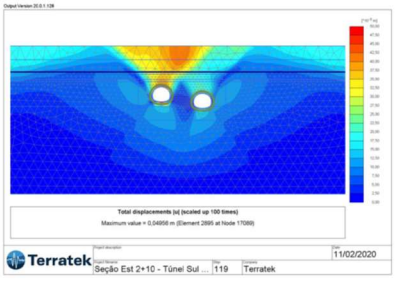


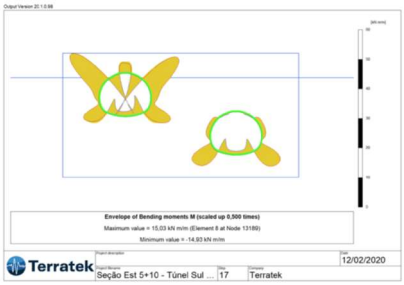
Services provided by Terratek:

Terratek was the designer and also carried out site investigation









Project datasheet **Mining**

Design of sheet piling tailings dams

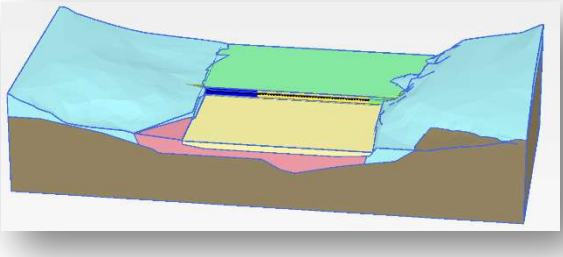
Location: Doce River, MG, Brazil

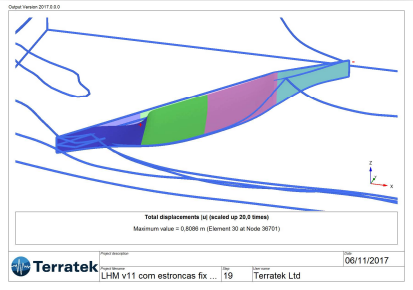
Client: Renova

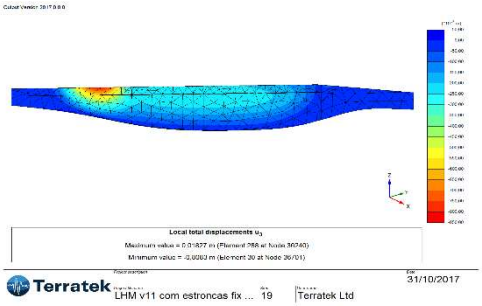
Description: Fundão dam failure in 2015 led the tailings to flow and pollute the Doce River. Vale and BHP Mining, owners of Fundão Dam, created the Renova Foundation to design and implement mitigation solutions for the disaster. One of them being three sheet piling dams across Doce River, to contain the tailings and enable dredging. Terratek was hired for a detailed Plaxis 3D analysis of the preliminary design and a monitoring programme with IPI's (in-place inclinometers). Plaxis 3D analysis showed a flaw in the preliminary design which would leed to large horizontal deformation on the sheet piling close to the right abutment and led to a thorough design review.

Terratek carried out:

- Analysis of existing site investigation;
- Plaxis 3D model of the sheet piling dam;
- Analysis of the results
- Monitoring programme.







Project datasheet **Mining**

Design of waste pile with geotubes

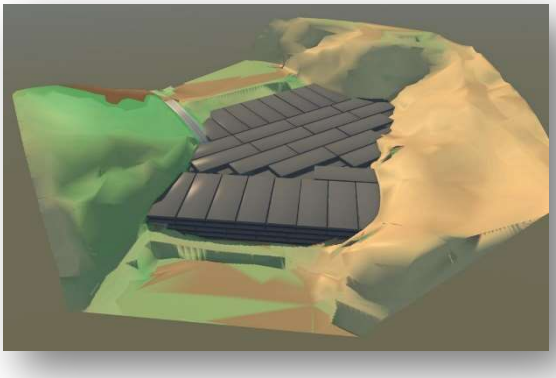
Location: Doce River, MG, Brazil

Client: Renova

Description: In the wake of Fundao Dam failure in 2015, the dam tailings flowed along Doce River and sedimented along its way. Vale and BHP, the owners of Samarco Mining, created the Renova joint-venture which in turn hired Terratek to design an innovative type of waste pile to be filled with tailings pumped from the Doce River.

Terratek carried out:

- Analysis of existing site investigation;
- Pile waste design;
- Monitored pilot test of geotube filling;
- Site supervision;
- Instrumentation and monitoring programme.



Terratek

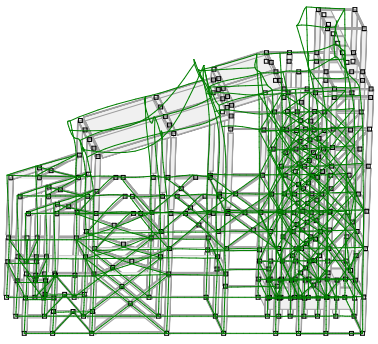
Project datasheet Mining

Structural Integrity Assessment

Location: Miraí, MG, Brazil

Client: Empa Contractors and Votorantim Mining

Description: Terratek carried out in 2008 a structural integrity survey of seven mining structures consisting of scrubber building, primary and secondary crusher structures, transfer and sampling towers. The job included dynamic measurements on selected locations on the structure, numerical modelling and model calibration, analyses of the results and design of reinforcements when needed.



Project datasheet **Mining**

Decommissioning of Mundo Mining Co Tailings Dams.

Location: Rio Acima, MG, Brazil

Client: MG State Public Works Dept

Description: Terratek carried out in 2017 and 2018 the decommissioning design for the abandoned gold mine. One tailings dam and the other is an arsenic-contaminated reservoir. These dams are located 2 km upstream of the water intake structure for the City of Belo Horizonte, and their failure would result in an enormous environmental disaster.

Services provided by Terratek

- Site investigation: drilling, sampling, lab testing, CPTU
- Geotechnical consultancy and design review;
- Contaminated water treatment design and plant;
- Drainage design;
- Geomembrane design over the existing tailings.

Project datasheet: Mining

Project name: SAG Mill Foundation

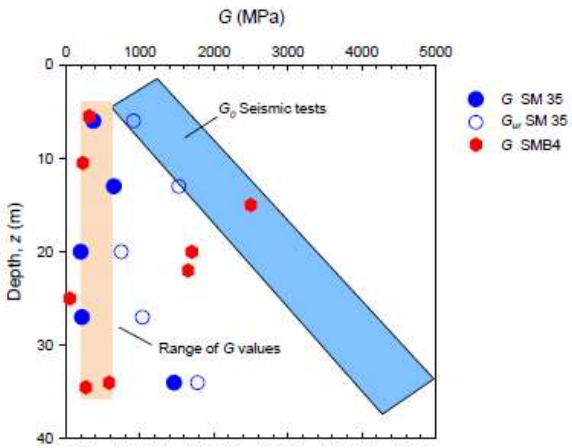
Location: Paracatu, MG, Brazil

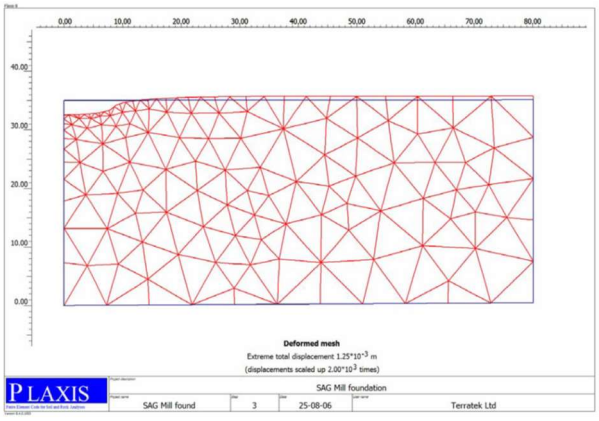
Client: Kinross Mining

Description: Back in 2007, RPM Mining, now Kinross Mining, carried out a large expansion project and the deployment of a new SAG Semi-Autogenous Grinding mill, 18 m in diameter

Services provided by Terratek

- Site investigation: drilling and sampling, PMT and seismic tests;
- Geotechnical analysis report;
- Dynamic numerical modelling of the foundation;
- Vibration monitoring for the commissioning of the structure.





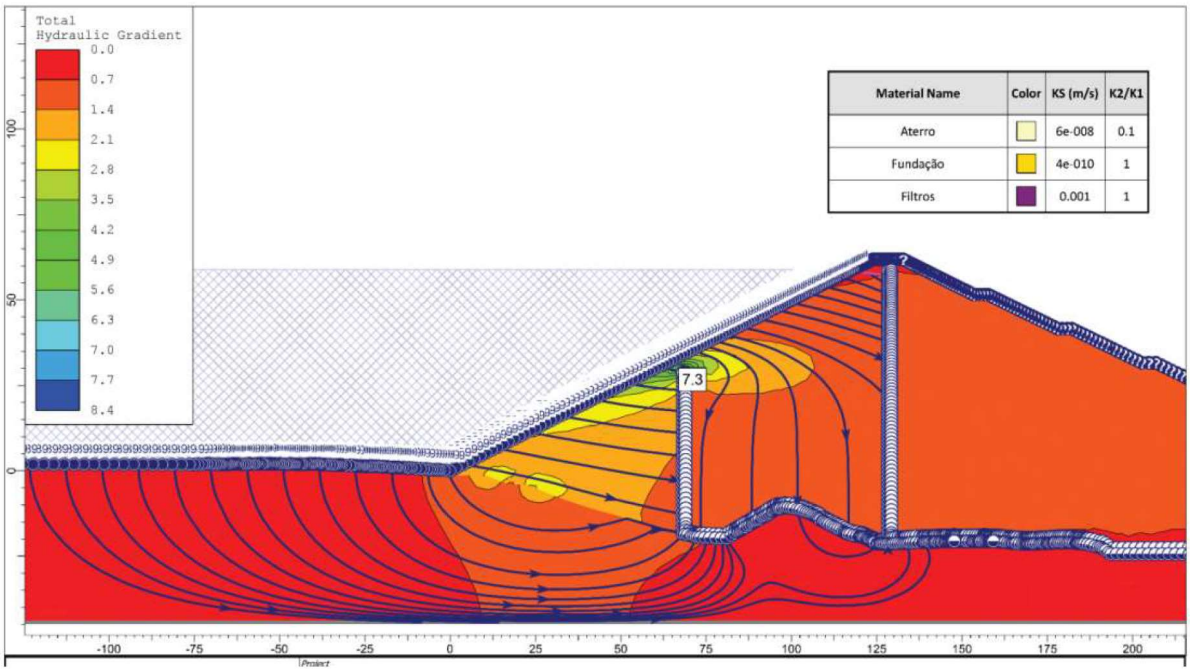
Project datasheet **Mining**

Design review of Maravilhas III Tailings Dam

Location: Nova Lima, MG, Brazil

Client: Construcap Contractors

Description: This is a tailings dam built by the downstream method and owned by Vale Mining. Construcap hired Terratek for the design review involving site visit and seepage, deformation and stability analyses. This work showed the need to redesign the rip-rap and high seepage gradients close to the top of the sand filter. Our recommendations also included improvement for the instrumentation programme.



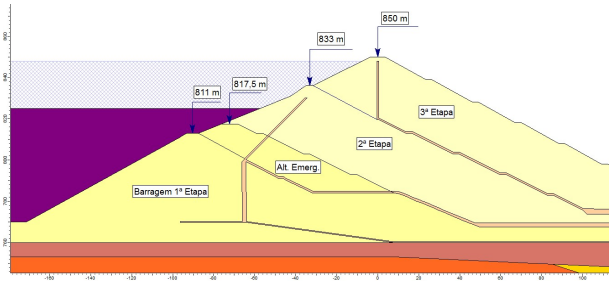
Project datasheet **Mining**

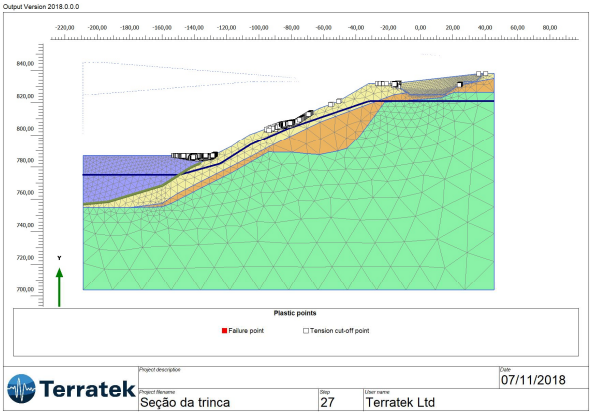
Itabiruçu Tailings Dam Design Review

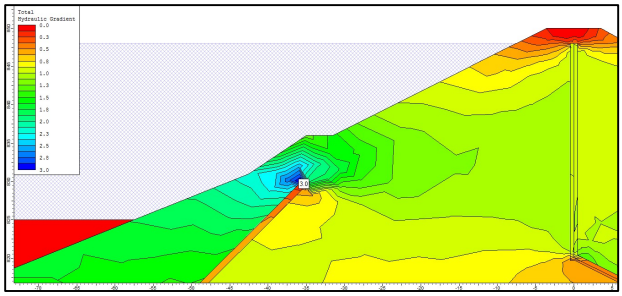
Location: Itabira, MG, Brazil

Client: Empa Contractors

Description: This is a tailings dam built by the downstream method and owned by Vale. Empa was awarded the contract to carry out the second lift and hired Terratek for the design review. The work included a site visit when the Terratek team observed a cross and another longitudinal crack through the compacted embankment dam. Terratek carried out document review and seepage, deformation and stability analyses. The deformation analysis showed tensile stress zones where the observed cracks took place This work showed high seepage gradients close to the top of the sand filter. Our recommendations also included the improvement of the instrumentation programme.







Project datasheet Dams

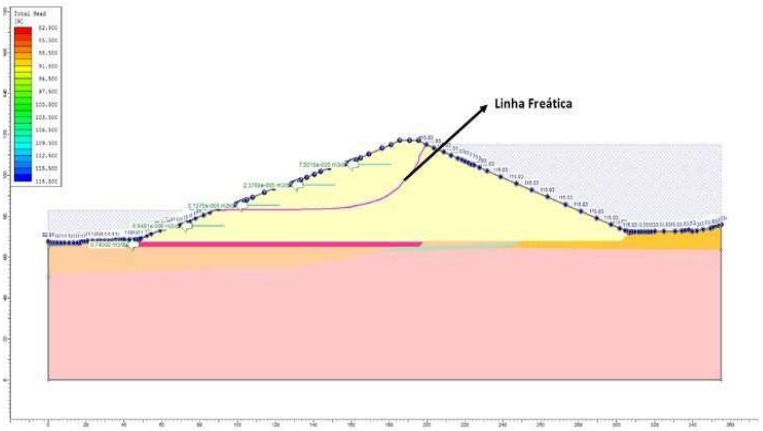
Project datasheet **Mining**

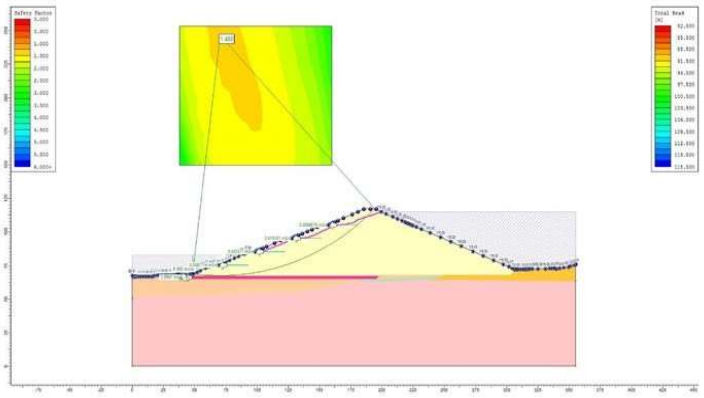
Sabão 1 & 2 Dams

Location: Serra do Salitre, MG

Client: Construcap Contractors

Description: These are water reservoir dams belonging to Norsk Yara Fertilizers Mining. Construcap is the contractor and hired Terratek for the design review. The work included a site visit, document review and seepage and stability analyses. Our analyses showed that the seepage analyses carried out by the designer was wrong due to the conceptual mistaken selection of compacted clay permeabilities, taken equally in the vertical and horizontal direction. This misconception led to recommendations to change the dams drainage system to avoid the phreatic water level crossing the downstream slope of the dams.





Project datasheet **Mining**

Avanco Dam Design & Construction Method Review

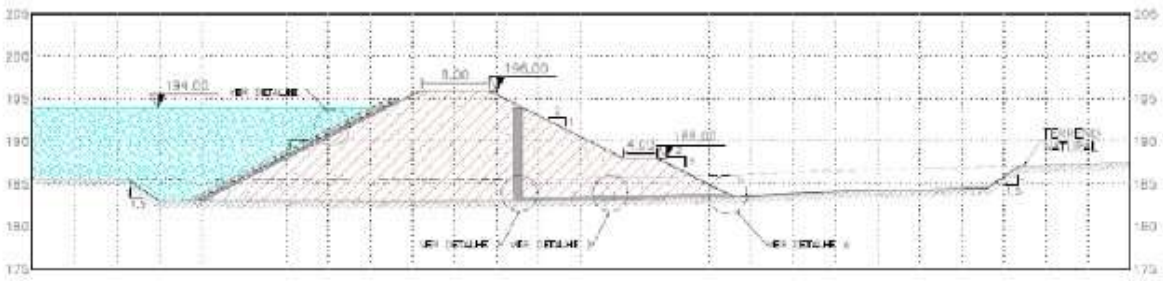
Location: Carajás, Curionópolis, PA

Client: Avanco Mining

Description: Avanco Copper Mining in the Amazon built during 2015 – 2016 a tailings dam, 11 m high, 320 m long embankment dam using the downstream lifting method. The drainage system consists of a horizontal sand blanket filter connected to the vertical chimney filter

Terratek provided the following services

- Site visit and safety inspection;
- Design review;
- Site resident engineering services;
- Final review & signoff report.



Project datasheet **Mining**

Germano Mining Dry Stockpile

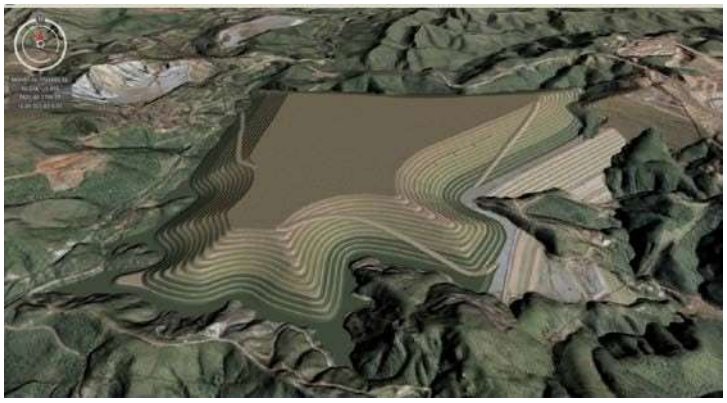
Location: Mariana, MG, Brazil

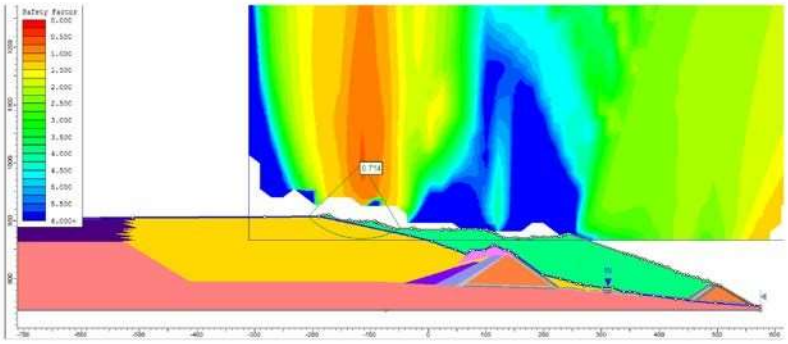
Client: Samarco Mining

Description: Samarco Mining awarded Terratek in 2013 a contract to carry out feasibility studies for a stockpile for the disposal of dry mine tailings.

Terratek provided the following services:

- In situ (CPTU, Seismic CPT, VST) and lab testing;
- Design and construction of a trial embankment on fine mine tailings;
- Probabilistic seismic hazard studies;
- Static and dynamic liquefaction susceptibility;
- Stability analyses.





Project datasheet **Mining**

Crusher wall design

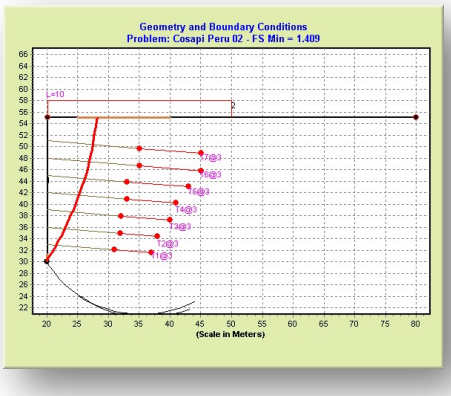
Location: Toquepala, Perú

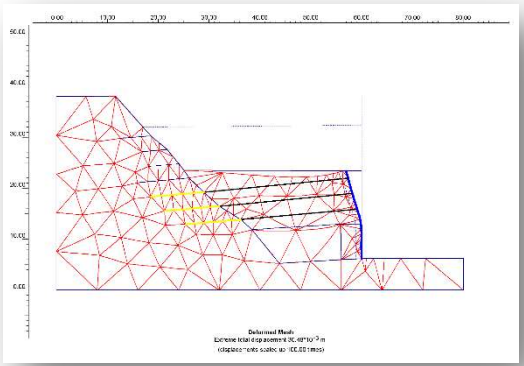
Client: Cosapi / Southern Peru Copper Co.

Description: A joint venture between Logus Ingeniería and Terratek carried out in 2004 the detailed design of a large and 35 m tall tieback wall for the Toquepala Mine new crusher. The mine is located on the Peruvian desert at highs exceeding 3000 m.

Terratek provided the following services:

- Site visit,
- Stability analyses,
- Plaxis 2D deformation analysis
- Structural design
- Earthqueke analysis
- Instrumentation and monitoring





Project datasheet **Mining**

Alemães Tailings Dam

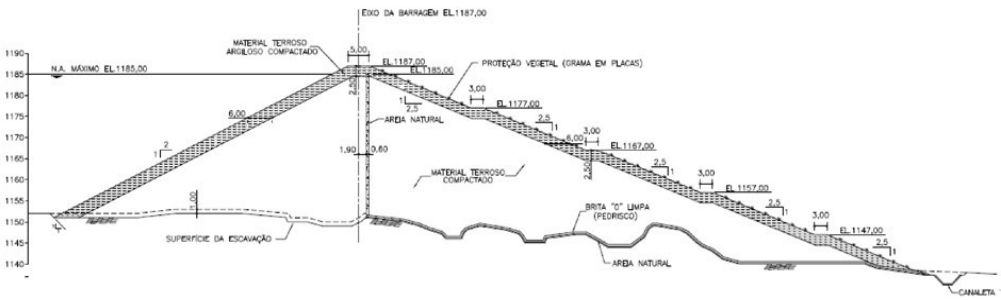
Location: Miguel Burnier Mine, MG, Brazil

Client: Gerdau Steel Co.

Description: This earth structure is a tailings dam constructed by the downstream method. The starting dam is 50 m high, 180 m long embankment founded on phyllite rock.

Terratek provided the following services:

- Site visit,
- Stability analyses,
- Instrumentation analysis;
- Design review and sign-off report

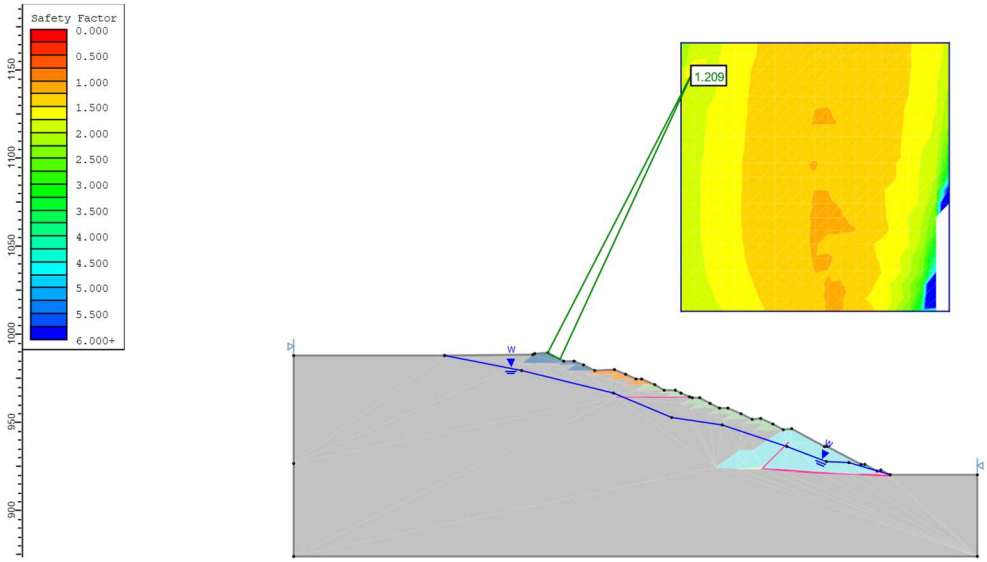


Project datasheet **Mining**

Itatiaiuçu Tailings Dam Review

Location, Itatiauçu, MG, Brazil
Client: Arcelor Mittal

Description: In 2009 Terratek was hired to investigate the stability of the tailings dam, about 100 m high and built by the upstream construction method. The work involved site investigation including in situ and lab testing and analyses. This work showed loose silty sandy tailings and a very high water level in the dam, close to the dam slope. Undrained laboratory testing showed liquefiable tailings with a cohesionless behaviour and a drained friction angle of 26 degrees. Stability analyses yielded a very low factor of safety FS = 1.25. Terratek's final report did not ensure dam stability.



Project datasheet **Mining**

Project name: Morro do Ouro Tailings Dam

Location: Paracatu, MG, Brazil

Client: Kinross Mining

Description: Morro do Ouro tailings dam is 4 km long and 120 m high, is among the world's largest dams of its type. Terratek provided geotechnical services from 2002 to 2008. It involves the dam and other structures such as the SAG mill foundation, slope stability of the pit,

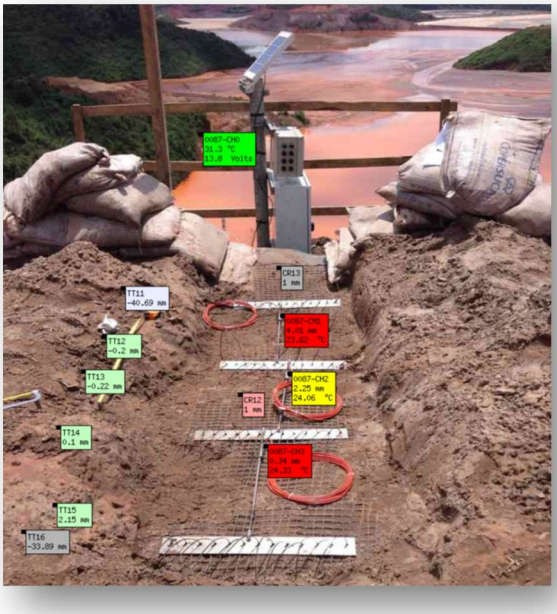
Services provided by Terratek

- Safety inspection;
- Geotechnical consultancy and design
- In situ testing, seismic piezocone
- Geophysical testing
- Flume tests to simulate tailings beach
- Safety review and sign-off reports
- Design and construction of a trial embankment over tailings
- Stability and liquefaction assessment
- Instrumentation and monitoring

Project datasheet **Mining**

Project name: Germano Tailings Dam

Location: Mariana, MG, Brazil



Client: Samarco Mining

Description: Germano tailings dam is 110 m high and, by the time of its completion in 2020 will be 140 m high. Terratek installed an automated monitoring system

Services provided by Terratek

- Supply of instruments; piezometers, hydraulic settlement cells, inclinometers, flowmeters, dataloggers
- Installation
- Datalogging
- Argus web-based monitoring system for all electrical instruments