Mining and Geosynthetics

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Content

Mining and Geosynthetics

How the global mining industry controls its costs and improves environmental performance

The daily mining rates, scale of single-site operations, and costs associated with mining increase every year. Advances in extraction technologies have greatly increased recovery rates from ore bodies. Mine designs previously thought to be too big to be possible are achieved every year or two so that an average mine today is significantly larger than an average mine just 10 years ago.

To construct on this scale, which is often necessitated by marketplace price points and competition for investor support, requires substantial engineering to make mines economically feasible and environmentally sound.

Geosynthetic materials are how mining companies achieve their goals

A large amount of the world's annual production of geomembranes is used by the mining industry, and for good reason. Heap leaching has grown substantially as a technique for extracting valuable material from ore. Ore heaps of 200m are being constructed. Mountaintop and "valley leach" designs are implemented. Geosynthetic lining systems contain the pregnant solution so that it is not lost in seepage into soils and does not flow into local waterways. Gold, copper, nickel, uranium, and even rare earths are being heap leached. Geosynthetics contain the valuable reserves and isolate the waste (the tailings), thus providing economic and environmental advantages to the site.

"Raincoat" liners keep stormwater out of ore heaps so that the pregnant solution is not diluted. Processing is more efficient this way. Also, geosynthetic lining systems protect water resources on site. With water costs in some regions having increased by 300% in the past five years, conserving water on remote mining operations significantly reduces expenses.

Containment isn't the only solution needed to keep mining operations competitive and viable. A vast range of geotechnical works is required for operational performance and environmental security. Geogrid reinforcement stabilises berms, embankments, crusher walls, and other soil structures. They support access roads so that 100 ton payloads can pass daily for years on site without costly roadway failures. (A mine can lose millions of dollars, USD, per day if an access road fails.) Geotextiles provide separation of granular layers, filter stability in geotechnical constructions, and protection of other geosynthetics.

In combination, these materials improve the recovery of valuable materials, isolate contaminated waste, keep sites open, and make closure a more efficient and less costly endeavour.

Naue Solutions

Naue solutions for the mining industry are engineered for long-term performance in all environments and with the chemical compatibility necessary to meet the economic and environmental goals of today's mining operations. Solutions include:

- Carbofol® high-density polyethylene (HDPE) geomembranes
- Bentofix® geosynthetic clay liners (GCLs)
- Secugrid® and Combigrid® geogrids
- Secutex® nonwoven geotextiles
- Secudrain® geocomposite drainage/gas venting materials

Heap Leaching

Without question, heap leach has become an enormous driver to the growth of mining operations around the world. Several decades ago, only about 3% of copper and gold supplies were produced through heap leaching. Today, the volume is surpassing 30% annually. Valuable chalcopyrite copper, previously not considered economical in heap leach development, is now heap leached, as is nickel laterite, uranium, and even rare earths.

The growth of heap leaching is heavily tied to the massive scale on which mines are being built, with some sites requiring huge investments. Heap leach stacks can near 200m as operations look to more quickly prove and sustain site yield.

Heap leaching accomplishes this, but only with the containment support of geosynthetics. Geomembranes and geosynthetic clay liners (GCLs) are used for heap leach pads liners, pregnant solution trench liners, processing pits, onsite water storage, raincoat covers over ore stacks to shed stormwater (rather than dilute the leach heap solution), and onsite wastewater management.

Geosynthetic lining solutions enable steep slope (including mountaintop) developments. Pregnant solution flows more easily from heaped ore, and valuable material is not lost in seepage into soils or local waters. Onsite water is managed more efficiently, which also improves site costs, as water and wastewater management is a major cost in mining.

In these ways, improving the economics of mining with geosynthetic containment solutions is also the best way to improve the long-term environmental performance in mining.

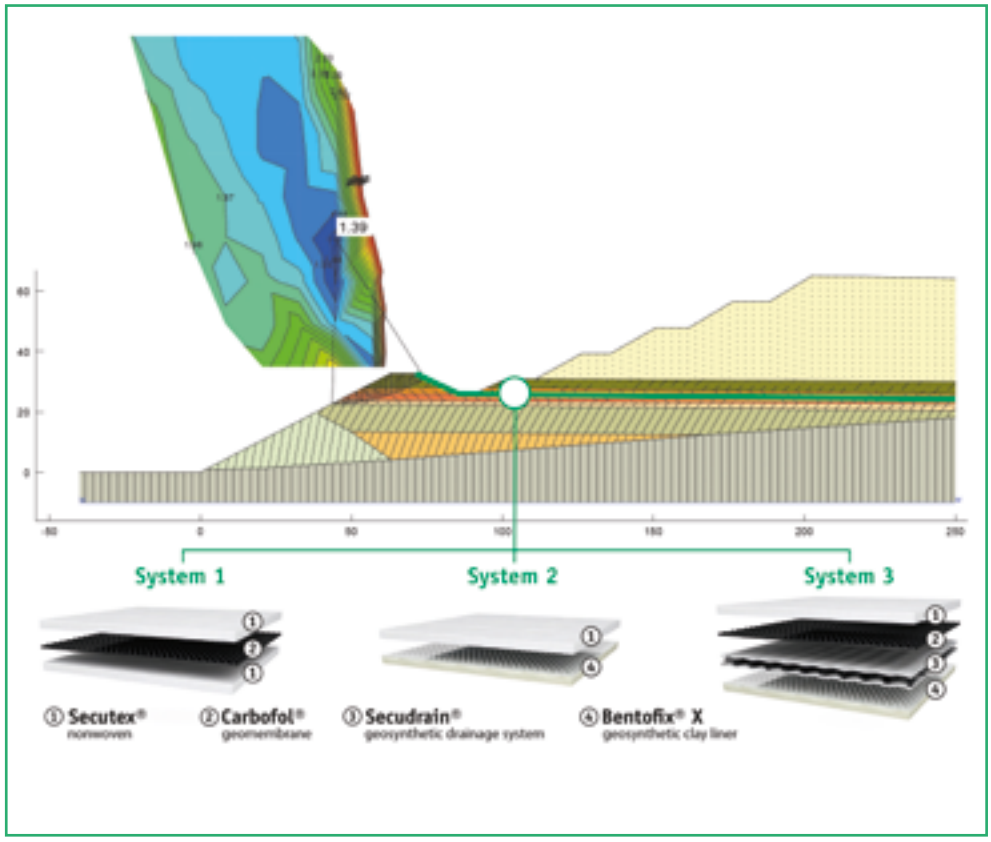


Figure 1: Three different solutions for a heap leach lining system

Naue Solutions

Carbofol® high-density polyethylene (HDPE) geomembranes feature exceptional chemical, stress crack, and UV resistance. They have the durability and chemical compatibility to withstand aggressive mining heap leach solutions in stacks and solution trenches. Available texturing can enhance the frictional characteristics necessary for lining system slope stability. And for onsite water management and processing fluid containment, Carbofol® is exceptional.

Geomembranes are not all that mining sites require. Secutex® geotextiles provide long-term, robust protection of and frictional stability for geomembranes on difficult terrain and in tall ore stack scenarios.

Additionally, composite lining solutions (Carbofol® geomembranes with Bentofix® GCLs) provide dependable, efficient, long-term lining performance for improved heap leach economics and environmental performance in nearly all mining operations.

Tailings Management

When an ore's valuable deposit, such as copper or gold, is extracted, what remains of the ore is waste. Often, it is a high percentage of the ore handled at the mine. Potentially contaminated from the extraction process or containing environmentally harmful components, tailings must be isolated to prevent long-term environmental damage.

Design engineers working on mines must allot significant space for proper containment of tailings. All or much of this area must be sealed with an impermeable geosynthetic (e.g. geomembrane) or composite lining system (e.g. geomembrane/geosynthetic clay liner). These sealing systems protect the base and walls of an impoundment. Often, the surface of the tailings will be covered by a geosynthetic system after cell or mine closure.

As mine sites increase in size, the engineering needed to properly contain the volume of tailings has intensified. This scaling up of containment frequently requires not just lining systems but reinforcement and sealing systems for perimeter berms on tailings pond. Weaker, earthen-only berms are at risk of saturation, erosion, and failure.

Furthermore, the increasing depth of tailings storage ponds requires stronger containment engineering design. The geosynthetics used must be durable and proven in aggressive environments over the long term. The depth of a tailings pond might exceed 75m, for example. In these cases, the contaminated, generally sludgy waste is too deep and hazardous for the lining and reinforcement system to be monitored. With the environmental security of the site relying on these environmental protection systems, the geosynthetics selected must be trusted.

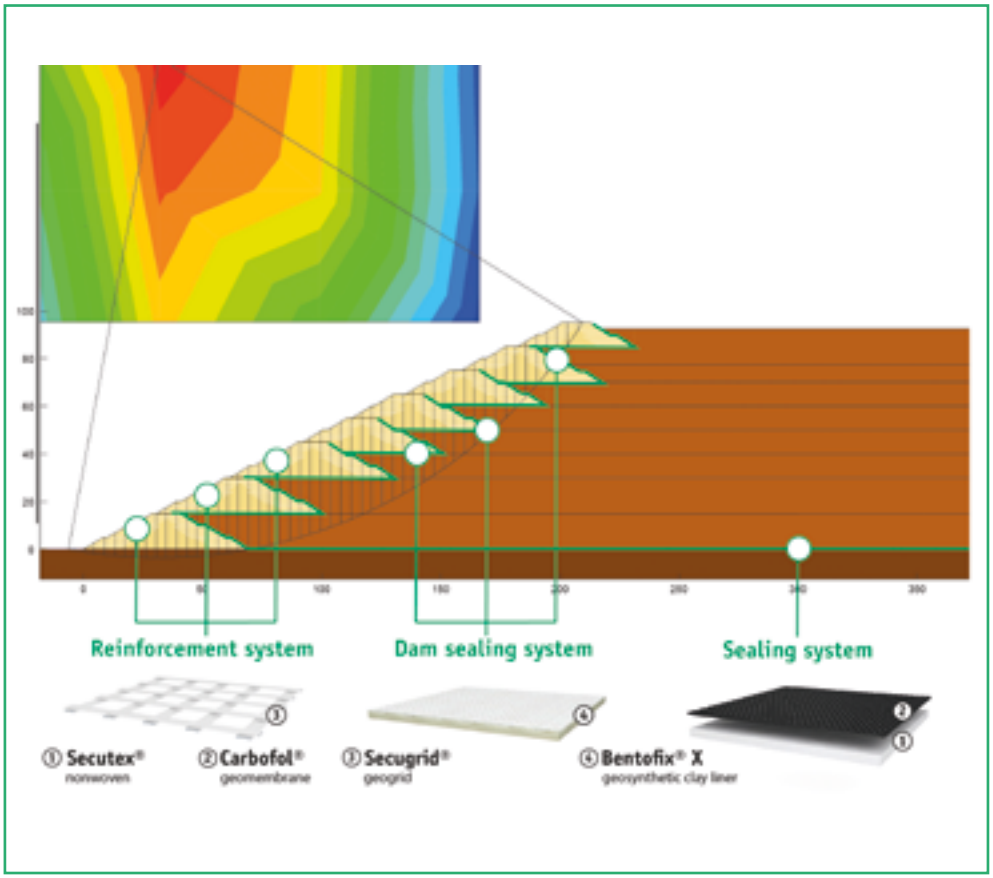


Figure 2: Lining system of a tailing storage pond with geosynthetics

Naue Solutions

Carbofol® high-density polyethylene (HDPE) geomembranes feature exceptional chemical, stress crack, and UV resistance. Their durability and chemical compatibility is well-supported by data and project records in tailings management.

Secutex® geotextiles provide long-term, robust protection of and frictional stability for geomembranes, berm filter control, slope stability, and more.

Secugrid® and Combigrid® geogrids offer high resistance to chemical and biological threats. Their homogenous flat bars and high-strength welded junctions offer long-term, robust reinforcement of soil structures.

Additionally, composite lining solutions (Carbofol® geomembranes with Bentofix® GCLs) provide efficient, long-term lining performance and exceptional environmental protection in tailings management installations.

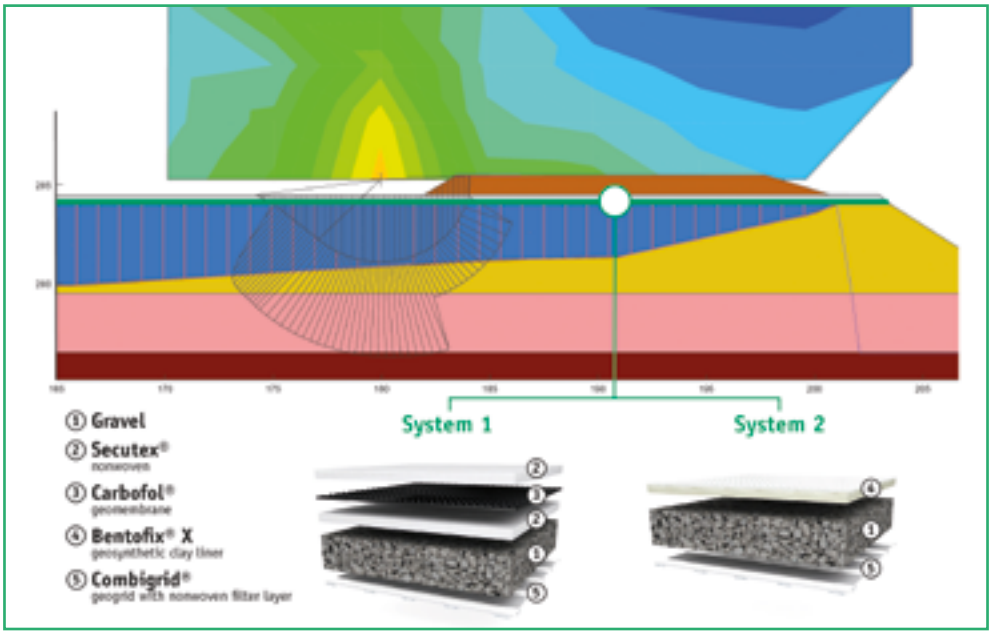


Figure 3: Capping of a tailing storage pond with geosynthetics

Evaporation Ponds

Evaporation is used in a variety of mining operations to separate valuable materials from water or brines. Diverse salts, for example, can be extracted by evaporation. Lithiumrich brines may be concentrated through evaporation. These materials, when harvested from solar ponds, are then able to be refined into items used across a wide variety of industries, in agriculture, in food products, etc.

For sites where remediation or isolation of a contaminant is a goal, the act of evaporation in an engineered pond can also be an effective solution, especially in the case of contaminated sediments.

The evaporation process generally requires a significant scale to be more efficient and economical.

Geosynthetic lining solutions are used to prevent the loss of valuable materials in seepage. They also provide strong environmental protection. The potentially aggressive nature of the material being mined by evaporation demands environmental care, especially with the concentrated masses that the evaporation process yields.

In many situations, pregnant solutions are pumped into the engineered pond for multiple cycles until the pond has been filled with a sizable enough harvest to economically justify collecting it. The system will likely be exposed to both the material of interest and difficult environmental conditions for a considerable period of time (e.g. years) before harvesting occurs.

As such, long-term performance and durability are essential for an evaporation pond lining system.

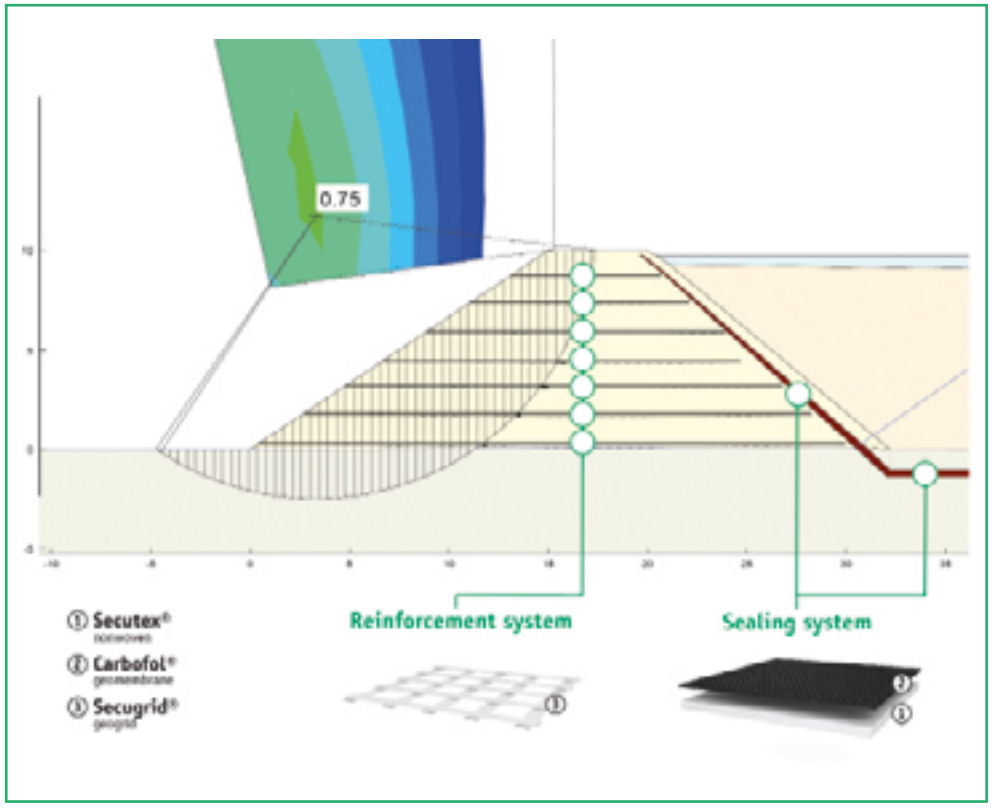


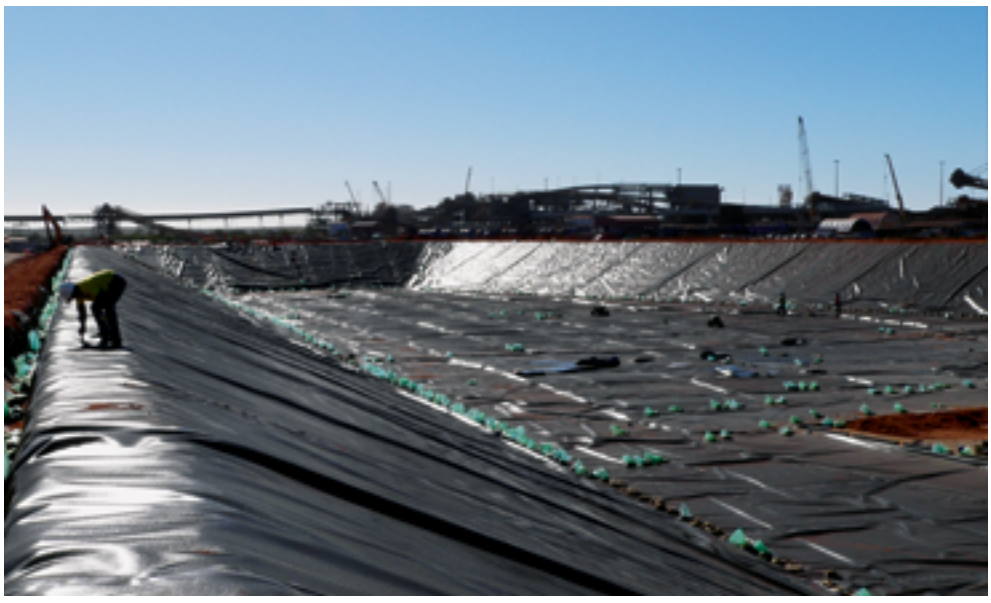
Figure 4: Lining system for an evaporation pond, including geogrid soil reinforcement of the dam structure

Naue Solutions

Carbofol® high-density polyethylene (HDPE) geomembranes feature exceptional chemical, stress crack, and UV resistance. Their durability in tough installation conditions makes them an ideal lining material for many mining installations, including evaporation ponds. Carbofol® is suitable for exposed and buried containment designs and robust against a wide variety of fluids used in mining operations.

Bentofix® geosynthetic clay liners (GCLs) can also be used in evaporation pond applications, depending on what is being contained. Just as one must ensure that a geomembrane polymer is chemically compatible with the solution to be contained, with GCLs one must check for chemical compatibility with the bentonite core. In more aggressive environments, Bentofix® coated GCLs, with their additional extrusion polymer barrier, might be the better solution.

Both Carbofol® and Bentofix® are engineered for strong, long-term containment in difficult environments. Their efficient rolls, including the 7.5m-wide Carbofol® option, enables considerable coverage, reducing installation time and on-site material waste.



Mine Closure

The life of a mine varies wildly. It could be shuttered after 6 months due to a swift decline in market prices for metals. That same site might be reopened 10 years later when a rise in prices makes the site economically viable again. A mine might operate for 20 years with little interruption, but over the course of those years change three times the type of valuable ore it processes. Ownership of the site can transfer multiple times. The development of new extraction technologies might cause some long-closed facilities to be reopened so that ore can be further exploited.

Whatever occurs during the active phase of a mine's life, the need for responsible closure is always present. Mining activities involve significant disturbance of soils. Dangerous chemicals are used. Environmental threats will remain after operations cease.

A number of measures will be used to treat and clean sediments on site in closure and a number of potentially harmful materials will be buried. Many sites strive to return similar vegetation to the area that existed there prior to the mine's development.

One of the most effective ways to improve the long-term safety of the site is to isolate what had been the mining zones (e.g. former heap leach or tailings storage facility) by installing a geosynthetic capping system.

Geomembranes, geosynthetic clay liners, geotextiles, and geocomposite drainage materials are used to cover, encapsulate, and cleanly isolate contaminated soils. These systems eliminate infiltration of precipitation, prevent polluted runoff, allow clean soil to be installed on top to support healthy vegetation re-establishment, and much more.

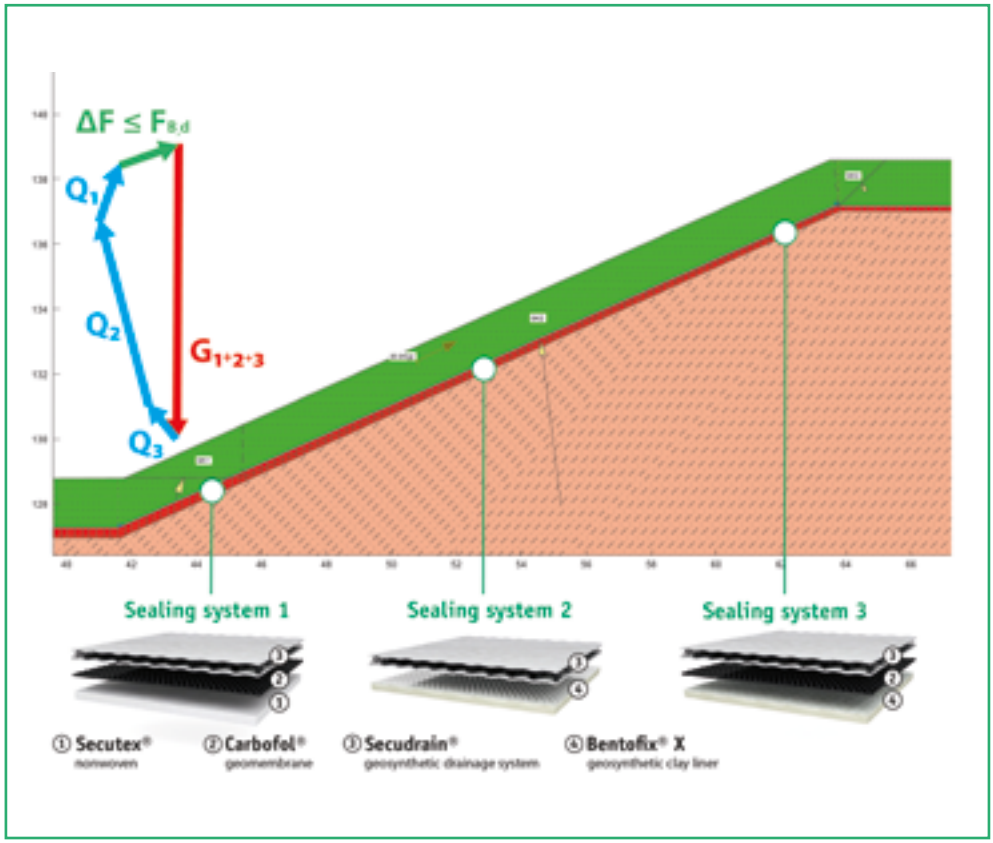


Figure 5: Geosynthetic closure solutions for mine sites

Naue Solutions

Carbofol® high-density polyethylene (HDPE) geomembranes feature exceptional chemical, biological, and stress crack resistance. Their long service lives in buried installations make them an ideal impermeable barrier for isolating contaminated soils, old tailings, and other environmental legacy concerns in mining.

Bentofix® GCLs provide efficient, long-term lining performance and strong environmental protection in capping applications. The polymeric coating on the Bentofix® X series provides additional protection against desiccation and root encroachment as well as enhanced gas barrier characteristics.

Secutex® geotextiles provide long-term, robust protection of liner system materials, encapsulation and separation of soils, and filter stability for efficient drainage within closure designs.

Secudrain® is a multifunctional composite material (geotextile and drainage core) that provides filtration, protection, and drainage for gas and water venting in closure systems.

Secumat® erosion control mats have a synthetic matrix that prevents the sliding and washing out of soil and cover layers while facilitating rapid vegetation growth.

Access Roads and Other Geotechnical Structures

Mines are, in many respects, small cities. They require roads, water, power, waste management, food, safety, housing, etc. Access roads are especially integral to a mine's viability. Ore must move around and away from the site. Shipments of supplies must not be impaired. Site access delays of a single day can cost a lot. Extended interruption in access to the site can threaten the mine's continued operation, as investors and mine owners might no longer consider it economically viable.

The massive vehicles used in mining today require extremely strong roads. Haulers carry payloads of more than 100 tons. For ore, oil sands, rock, and coal operations, the roads must sustain repeated passings of these vehicles over years of mine activities.

Geogrid reinforcement materials and separation geotextiles are used to redistribute the tensile forces within the road and prevent the mixing of fines and coarse aggregate. The increased road strength mitigates the risk of road erosion and rutting in wet or arid mining environments.

These same reinforcement, separation, and drainage control materials are used in various other geotechnical applications in mining. The difficult terrain that characterizes many sites requires a number of vertical or near vertical constructions to be built, such as to support crusher walls. Geosynthetic reinforced soil structures, reinforced with geosynthetics, are a common and effective strategy. Also, there are embankments, abutments, operating pads beneath heavy equipment and cranes, and many other points at which soils must be reinforced to enable the little city that a mine is to function as designed.

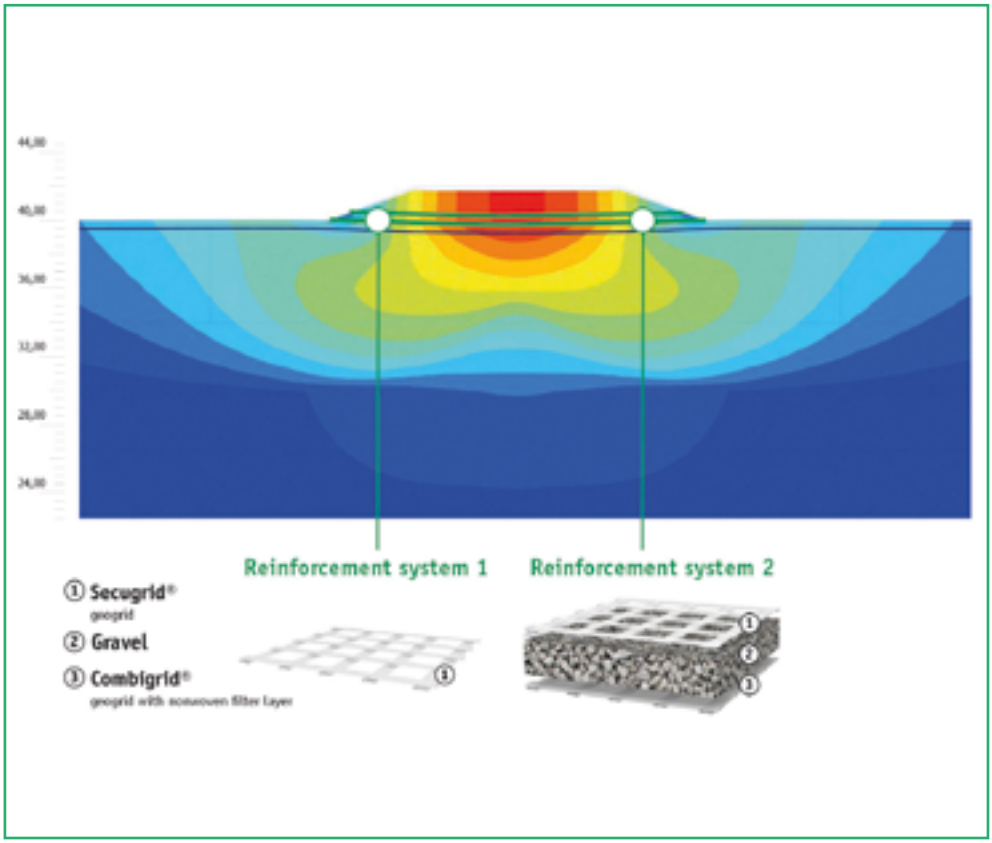


Figure 6: Geogrid reinforcement solutions for access roads

Naue Solutions

Secugrid® geogrids offer long-term, robust reinforcement of roads and soil structures. Secugrid® geogrids achieve a high modulus and high strength at low elongations, which enables them to deliver long-term performance in road and railway reinforcement, geosynthetic reinforced soil structures, veneer stabilisation, embankments, load transfer platforms, and other demanding applications.

Secutex® geotextiles deliver filter stability and robust protection for high-level performance in protection, separation, filtration, and drainage in geotechnical applications. The densely needle-punched, nonwoven matrix of staple fibres in Secutex® keeps granular layers in place and provides efficient in-plane transmissivity for support in road, wall, and other engineered structures at a mine.

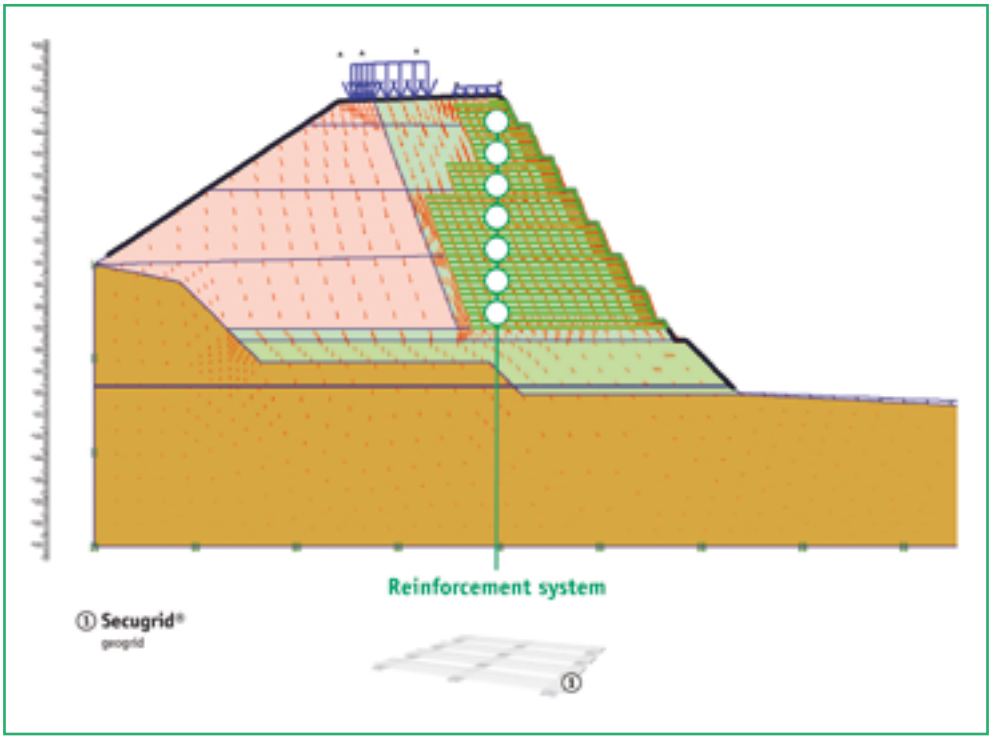


Figure 7: Soil reinforcement for mechanically stabilised earth walls

Approvals for the Naue Group

Bentofix® BFG 5000
Bentofix® X2 BFG 5300

Secugrid® Q6 and R6

Secugrid® HS R6

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