IF YOU CAN’T STACK ORE
YOU CAN’T MAKE MONEY
Gold Solution Loss

Assumption: 40 Hectare Leach Pad - Gold $1,200 Ounce

10 YEARS
$1,748,976

5 YEARS
$3,485,953

1 YEAR
$1,797,444

Copper Solution Loss

Assumption: 40 Hectare Leach Pad - Copper $3.00 lb

10 YEARS
$1,797,444

5 YEARS
$1,797,444

1 YEAR
$1,797,444

WHAT DO LEAKS COST YOU?

On average, geomembranes experience 4 holes per hectare after they are installed. Estimated leakage through these holes ranges from 340 to 3,400 liters per hectare per day (lpdh). (1)

What Causes Leaks?

71% Stones
16% Heavy Equipment
6% Seams
6% Installer
1% Cuts

87% of defects occur during cover soil placement.

Probability Of Significant Leakage

"By performing a leak detection survey before leach pad operation, the PLS would not be lost through holes that would otherwise go undetected." (2)

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**RECOVER METAL FASTER**

72% Of Mines Experience Construction Delays.

Days Saved Using GCL vs Clay
- **Clay Installation Time**: 198 Days
- **GCL Installation Time**: 99 Days

Days Saved Using MineDrain vs Stone
- **Stone Installation Time**: 99 Days
- **MineDrain Installation Time**: 50 Days

**50%**

GSE Geosynthetics install 50% faster than stone or clay.

**RECOVER METAL SAFELY**

Truck Traffic is reduced by 95% when using geosynthetic systems, resulting in a smaller carbon footprint and safer work environment.

**RECOVER METAL SAFELY**

**How much do construction delays cost you?**

- **72%** Of Mines Experience Construction Delays.

- **Days Saved Using GCL vs Clay**
  - **Clay Installation Time**: 198 Days
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- **50%**
  - GSE Geosynthetics install 50% faster than stone or clay.

**Liner System Performance**
A GSE geomembrane and a GSE geosynthetic clay liner (GCL) reduce the potential leakage rate to nearly 0 lphd after overliner is placed, safely containing solution.

**PUBLIC RELATIONSHIP RISKS ASSOCIATED WITH ENVIRONMENTAL PROTECTION**
- **Government Relations**
- **Community Relations**
- **Share Holder Relations**

**Zero** liters of water are required to install GSE GCL.

**19,424,108 liters of water are required to install clay for a 400,000 m² leach pad.**

**Linex System Performance**
A GSE geomembrane and a GSE geosynthetic clay liner (GCL) reduce the potential leakage rate to nearly 0 lphd after overliner is placed, safely containing solution.

**HOW MUCH DO CONSTRUCTION DELAYS COST YOU?**

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- **50%**
  - GSE Geosynthetics install 50% faster than stone or clay.
GSE WHITE LEAK LOCATION LINER:
The electrically conductive bottom layer helps you find and repair leaks quickly to prevent mineral and solution loss.

GSE HIGH PERFORMANCE WHITE GEOMEMBRANE:
This durable liner maintains its physical properties during long-term exposure in mining applications that demand protection against solution loss and environmental damage.

GSE MINEDRAIN:
This drainage system was engineered specifically for mining applications that demand superior flow and filtering, such as leach pads and tailings storage facilities.

GSE HIGH TEMPERATURE LINER:
This geomembrane can take the heat produced during exothermic reactions and withstand temperatures up to 100 degrees Celsius.

GSE GEOSYNTHETIC CLAY LINER:
This durable, cost-effective alternative to compacted clay installs quickly and maintains a consistent quality in a variety of mining applications.

GSE WHITE LEAK LOCATION LINER:
This geomembrane is specifically designed to prevent leaks and identify them with ease, ensuring your mining operation remains efficient and environmentally safe.

GSE HIGH PERFORMANCE WHITE GEOMEMBRANE:
This durable liner maintains its physical properties during long-term exposure in mining applications that demand protection against solution loss and environmental damage.
HEAP LEACH RECOVERY WITH GSE

With millions of square meters installed in mining operations around the world, GSE GEOMEMBRANE LINING SYSTEMS are proven to be the most durable, dependable and cost-effective containment solution in heap leach pads. Our liners are made from the highest quality resins and exhibit superior resistance to punctures, stress cracking, and harsh chemicals. Available in wide width panels, GSE geomembranes require fewer welds, so they install faster and leave fewer opportunities for leaks.

For applications requiring placement on steep slopes, GSE offers textured sheet to increase the frictional resistance between natural soils and other geosynthetics in contact with the liner. When the hot sun threatens to interrupt installation, GSE WHITE GEOMEMBRANE reflects the light and keeps the liner cooler, resulting in fewer wrinkles and allowing installation to continue.

Sometimes damage occurs during liner installation or while placing overliner material on the pad. It is vital to find these leaks quickly and repair them before serious damage occurs. GSE LEAK LOCATION LINER installed using GSE IsoWedge technology allows electrical liner integrity (ELI) testing on both exposed and covered applications, on slopes, across seams, and over wrinkles, providing the most accurate and cost-efficient leak detection method in the industry.

When you need a liner that can take the heat produced by exothermic reactions, specify GSE HIGH TEMPERATURE GEOMEMBRANE. This liner is uniquely formulated to maintain its physical properties in applications with sustained temperatures of up to 100°C (212°F). In laboratory tests at elevated temperatures, GSE High Temperature Liner showed improved tensile strength and superior resistance to stress cracking, punctures, and UV degradation, making it essential for high-temperature applications where liner integrity and long service life are required.

In heap leach pads, it is necessary to install an excellent drainage system in order to keep the leachate flowing freely to the collection ponds. Traditionally, crushed stone of a specific gradation is excavated and transported to the pad in what is often a time-consuming and expensive process. In addition, placing gravel directly against the geomembrane may cause damage. GSE MINEFLO GEOMEMBRANE is an innovative high-flow, high-strength drainage system that performs better than natural gravel and withstands the high loads of overburden ore or vehicle traffic. GSE MineDrain installs quickly and protects the geomembranes from punctures.

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Solution Ponds

Solution ponds demand the most durable containment lining systems available. Pond liners are exposed to the elements and rigorous use, and they must be able to both protect the environment and protect against solution loss, so your precious metal, and profits, don’t get washed away. In remote or arid regions where water is scarce, liners and floating covers are needed to preserve the water supply and help prevent evaporation.

GSE High Performance Geomembranes are the most flexible HDPE liner on the market and were designed for endurance. They include a specially engineered additive package to ensure the liner maintains its superior mechanical properties, even in the harshest conditions. Should the application require regular leak location surveys, GSE Leak Location Liner can be tested prior to operations and year after year, whether exposed or covered. GSE geomembranes can be combined with GSE Geonets or GSE MineDrain Geocomposite to create a complete leak detection and containment system.
Tailings Storage Facilities

The tailings, or materials left over after the milling or recovery process, often contain metals and chemicals and must be stored responsibly so they don’t harm the environment. Disposing of mine tailings is one of the most important environmental issues that mine companies face. Lining tailings ponds with GSE High Performance Geomembrane creates an impermeable barrier and prevents the release of mining refuse into the environment. GSE MineDrain, in this application, acts as a layer of protection for the geomembrane, reducing the potential for tears and leaks. In addition, the GSE MineDrain geotextile can be modified to filter fines from the water.

Mine Closure and Capping

When disposing of tailings, acid-producing waste rock, and spent heaps, it is necessary to properly cap the waste to minimize the intrusion of air and water, which can cause the sulfides to oxidize and release harmful substances. Studies conducted by the US EPA have shown that a composite cover system, consisting of a geomembrane and geosynthetic clay liner (GCL), performs better than compacted clay liners or store-and-release covers. GSE BentoLiner NWL GCL combined with a GSE geomembrane is the most durable, reliable composite cover system available on the market today.
Concrete Protection

Solvent Extraction and Electrowinning Process (SX-EW)

SX-EW is a two-stage process that first extracts and upgrades copper from low-grade leach solutions into a solvent containing a chemistry that selectively reacts with and binds the copper in the solvent. The copper is extracted from the solvent with strong aqueous acid which then deposits pure copper onto cathodes using an electrowinning procedure. SX-EW processing is best known for its use by the copper industry, where it accounts for 20% of worldwide production. However, it is also successfully applied to a wide range of other metals, including cobalt, nickel, uranium, and zinc. Many facilities use concrete tanks during the SX-EW process, and the concrete is susceptible to corrosion from the highly acidic solutions. GSE StudLiner is a high-density polyethylene (HDPE) concrete protection product with integrated studs that lock the liner to the concrete surface. It has the highest pull-out strength compared to other products, and GSE StudLiner provides higher resistance to mechanical, chemical, and environmental threats than concrete alone. Ultimately, increasing the life of the concrete structure, it is less costly than coatings, and GSE StudLiner allows engineers to reduce the required thickness of the concrete without sacrificing performance. GSE can construct prefabricated panels customized to any project’s exact dimensions and specifications.
Safety and Stability

Mine Safety
In underground mines, GSE Geogrids act as a screen on roofs and walls to prevent debris from falling on workers. Manufactured from high-quality flame-retardant resin, GSE Geogrids are durable yet lightweight, corrosion resistant, and easy to handle, allowing for quick, safe installation.

Soil Stability
GSE Geogrids offer reinforcement and stabilization solutions in surface and underground mining applications. Mining sites and the roads used to access them often are built on unstable soils that are not naturally suited for construction. Traditional soil stabilization methods are expensive, time-consuming processes that require specialized equipment and skilled labor. Soil Stabilization Geogrids provide a quick, long-term solution to stabilizing and strengthening roads and work sites and reducing the thickness of aggregate base layers. GSE Uniaxial Geogrids provide the reinforcement solution to building steep slopes and tailing dams that saves valuable spacing and construction cost. The stiff, net-like structure of a geogrid confines stone and soil particles, preventing lateral shear when a vertical load is applied. Compared to traditional stabilization methods, geogrids install in any weather, offer immediate, permanent stabilization, and typically cost 20%-50% less.
GSE knows what’s at stake when it comes to environmental protection and preventing solution loss. That’s why we manufacture the most durable, long-lasting geosynthetic containment systems designed to prevent leakage and corrosion in mining applications. Our geosynthetics install faster, perform better, and are more cost-effective than using natural materials such as stone, gravel or compacted clay. With GSE geosynthetic systems, your project won’t be delayed due to a shortage of quality natural materials or the logistical difficulty of transporting in remote locations. You can be assured that our products are always available, and their performance is always consistent. **BECAUSE IF YOU CAN’T STACK ORE, YOU’RE NOT MAKING MONEY.**
GSE Leak Location Liner

A revolution in leak detection, GSE Leak Location Liner is an HDPE or LLDPE geomembrane with a fully integrated electrically conductive bottom surface. This allows quality teams to conduct a spark test immediately following installation and a dipole survey after the liner is covered, for the fastest, most comprehensive leak detection available on the market. While other conductive liners exist, only GSE Leak Location Liner installed using GSE’s IsoWedge technology facilitates dipole testing after cover material is placed. Studies have shown that using both spark and dipole survey methods decrease the probability of leaks. Like all GSE geomembranes, Leak Location Liners are available in a variety of colors, and one or both sides of the liner can be textured.
GSE High Temperature Liners are high density polyethylene (HDPE) geomembranes specifically designed to withstand temperatures up to 100°C (212°F). At elevated temperatures, standard liners will break down, accelerating stress cracking and oxidation, which leads to leakage. GSE High Temperature liners retain their mechanical properties, even in the high temperatures produced from exothermic reactions during mining operations.

GSE Geogrids
GSE Geogrids are synthetic reinforcement and site stabilization products. Manufactured from the highest quality HDPE resin for uniaxial geogrids and PP resin for biaxial geogrids, they are extremely resistant to chemicals commonly used in mining applications. They prevent slope failure, improve bearing capacity, and increase stability under non-improved roads and other sites where the natural soil is too weak to support heavy loads. In underground mines, geogrids can protect workers from falling debris.

GSE High Performance White Liner
GSE HP White is more than just a white-surfaced geomembrane. It is specifically engineered to have excellent physical properties, UV resistance, and extended lifetime. The white surface reflects the hot sunlight and keeps the liner cooler, decreasing the amount of thermal expansion and contraction, thereby reducing the amount of wrinkles in the liner system. Below the white reflective upper surface, a black primary layer. This black layer, exposed against the white surface, makes it easier to visually spot damage. For applications requiring placement on steep slopes, one or both sides of the liner can be textured to increase the frictional resistance between the liner and the soil below to prevent slipping.

GSE SBx Geogrid
GSE SBx Geogrids are synthetic reinforcement and site stabilization products. Manufactured from the highest quality HDPE resin for uniaxial geogrids and PP resin for biaxial geogrids, they are extremely resistant to chemicals commonly used in mining applications. They prevent slope failure, improve bearing capacity, and increase stability under non-improved roads and other sites where the natural soil is too weak to support heavy loads. In underground mines, geogrids can protect workers from falling debris.
GSE BentoLiner NWL is a needle-punched reinforced GCL comprised of a uniform layer of sodium bentonite clay, encapsulated between a nonwoven and a scrim-nonwoven geotextile, to form a highly impermeable barrier that often replaces thick layers of expensive compacted clay. The scrim-reinforced backing prevents GSE BentoLiner mats from shrinking, so once installed, they maintain overlap. GSE BentoLiner GCLs are known for their consistency and longevity because only bentonite clay of the highest quality, free from additives and fillers, are used. GSE offers a variety of fabric-encased GCLs designed to accommodate different load and slope requirements, and to address the specific challenges associated with mining applications.

GSE Studliner is a high-density polyethylene (HDPE) concrete liner that protects against chemical and mechanical damage to concrete structures. GSE Studliner is manufactured with approximately 100 studs per square foot to guarantee high pullout strength and provide excellent stress distribution during temperature changes and pressure build-up. It can be installed over an exposed surface of a new or existing concrete structure, and it will provide a life expectancy that is five times greater than that of an unprotected structure. The product is available in either gray or black and in a variety of sizes to fit each specific application.

GSE MineDrain Geocomposite is a highly-engineered drainage system that consists of GSE PermaNet geonet heat bonded on one or both sides with a GSE nonwoven needle-punched geotextile filter. It was designed specifically for mining applications that demand superior flow and filtering performance, and holds up under high compressive loads.
THIS IS WHAT WE'RE MADE OF.

Multiple Layers Of Reliability
GSE geosynthetic products are known throughout the world as a mark of quality and reliability. And that’s not a reputation you get by chance. All GSE products are backed by extensive manufacturing quality assurance (MQA) testing performed at our own GSE-LAP accredited laboratories. Our MQA program starts with testing specially formulated resins and other raw materials to guarantee they are of the highest quality. Our rigorous testing continues throughout the manufacturing process, all the way to the job site. All GSE geomembranes are 100% spark tested for pinholes to ensure every roll delivered is leak free.

Collaboration And Support
At GSE, we believe success is always a collaborative effort. Our engineering support staff is comprised of multidisciplinary product professionals to support every aspect of your project design, from concept to installation. They will listen to your needs, and do whatever is necessary to provide a purpose-fit solution.
References

1. Forget, Benoit et al., 2005. “Lessons Learned from 10 Years of Leak Detection Surveys on Geomembranes.” Sardinia Symposium, Sardinia, Italy.


