

## LAYING THE GROUNDWORK

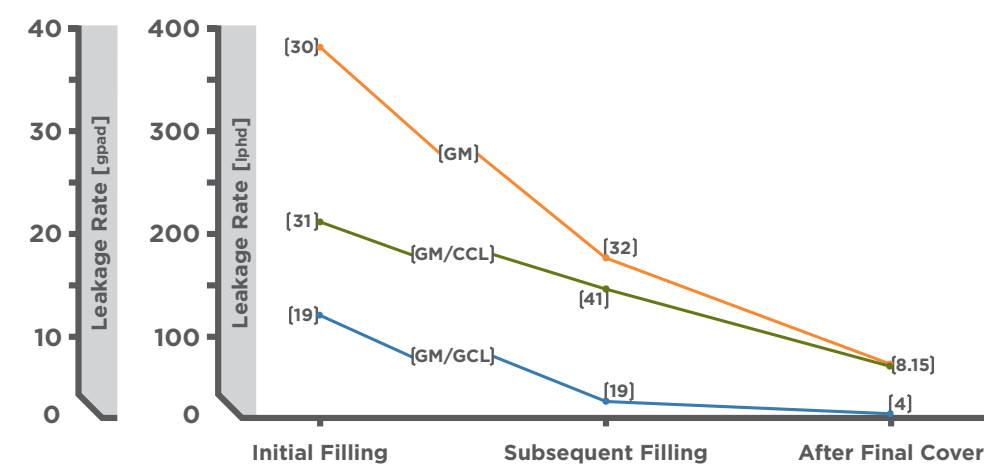
While the use of geosynthetic geomembranes in coal ash landfills and ponds has been shown to provide superior protection compared to not using a liner, there is still significant risk of leakage when a geomembrane is installed without additional geosynthetic products, such as geosynthetic clay liners, as shown in the diagram below.

GSE has been a worldwide leader in the manufacturing of geosynthetic waste containment barrier systems for decades. Our geomembrane and geosynthetic clay liners have been instrumental in providing utility companies with a solution that addresses the various concerns associated with coal power generation. Now GSE is the first to develop a complete Coal Ash Barrier System using products that comply with anticipated regulatory standards to maximize groundwater protection and minimize both risks and cost.



GSE product testing laboratory, Houston.

### [→] LANDFILL LINER SYSTEM PERFORMANCE



[Ref: 2002 Bonaparte, Daniel and Koerner, U.S. EPA]

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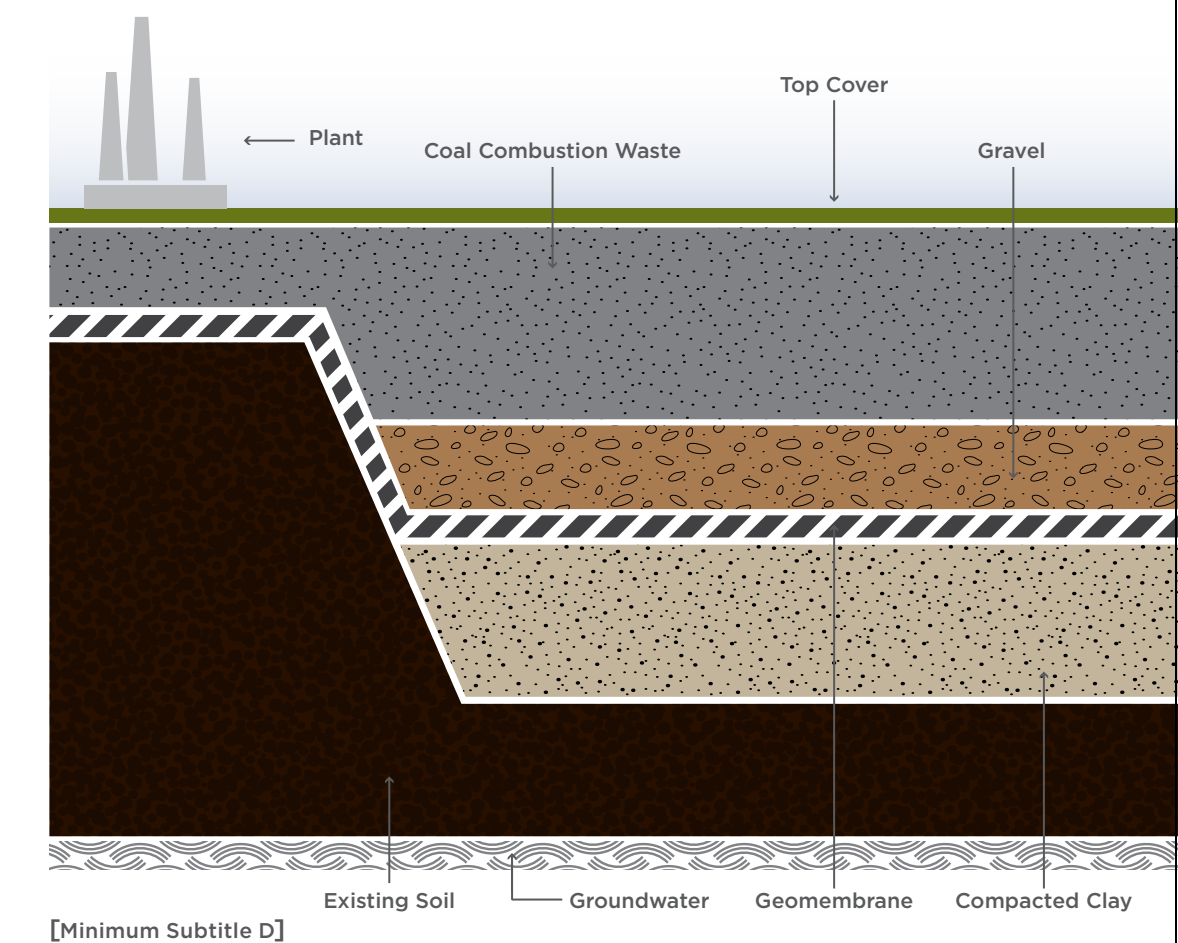
## FACING THE CHALLENGE

In recent years, the storage of coal ash has become an increasing concern. Power facilities and utility companies have realized and experienced the consequences of inadequate coal ash containment, and the possibility of contaminated groundwater has brought the issue to the forefront.

The EPA conducted a study that categorized coal ash as Subtitle D waste and determined that regulations were warranted. However, regulations were never put into place. But incidents of groundwater contamination at or near coal combustion residual storage facilities have resulted in the EPA considering new regulation of coal ash storage and significant companion actions on the legal, federal congressional and multiple governmental fronts.

In light of pending regulations, utility companies are attempting to better contain coal ash using EPA Subtitle D minimum guidelines, but are facing multiple challenges, including:

- [→] Investing time and resources into the management of coal ash containment
- [→] Availability of suitable earthen materials and the economic and environmental impacts of borrowing materials
- [→] More stringent assessments of groundwater and the risk of third party issues
- [→] Addressing opponents and concerned communities
- [→] Difficulty finding sites for disposal or gaining permits to build new facilities
- [→] Managing impact to power costs and consumer rates
- [→] Increased scrutiny by state officials



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## COAL ASH BARRIER SYSTEM

## WITH GSE, YOU'RE COVERED

Proposed regulations require every coal ash landfill to be sufficiently capped to prevent groundwater contamination. GSE's durable geosynthetics ensure the highest level of protection and compliance possible.

### Composite Liner System

A composite liner system combines the low permeability of a polyethylene geomembrane with the self-sealing characteristics of bentonite clay to provide the best leak protection in the industry. In many cases, the geosynthetic clay liner can replace the compacted clay layer.

### Geomembrane

A geomembrane covers the composite liner system. GSE's High Performance White Smooth geomembrane is an ideal choice for coal ash capping because its UV-stabilized upper white surface reflects light, enables damage detection, and reduces wrinkles and subgrade desiccation.

### Geocomposite

The composite drainage product overlays the geomembrane and can be used to replace earthen drainage materials. GSE offers an extensive line of geocomposite products that save time and money and provide greater consistency than natural soil materials.

## ENGINEERING SUPPORT



The GSE Engineering Support Staff is comprised of multidisciplinary product professionals to support every aspect of your project design, from concept to installation. Rely on our project team to help you solve your design challenges.

Our extensive network of industry experts offer comprehensive:

- [→] Alternative solution development and assessment
- [→] Project management
- [→] Technical support
- [→] Design tools
- [→] Customer service

## MULTIPLE LAYERS OF RELIABILITY



GSE collaborated with leading utility companies to develop its Coal Ash Barrier System, which outperforms other Subtitle D-like constructions. It's the only system of its kind and combines three of our innovative geosynthetic products working in tandem to provide superior results.

### Benefits Over Minimum Subtitle D

- [→] Provides greater durability, consistency and reliability than standard Subtitle D liner systems at a potentially lower cost
- [→] Reduces risks of groundwater contamination
- [→] Ensures compliance with current and future government regulations
- [→] Increases landfill capacity and optimizes land use
- [→] Easier and quicker to install, so you stay on schedule

## COAL ASH BARRIER SYSTEM



### Bentoliner Coal Ash Resistant GCL

Our Bentoliner coal ash resistant geosynthetic clay liner (GCL) combines geosynthetics with sodium bentonite clay to form a highly impermeable barrier that often replaces thick layers of expensive compacted clay liners. GSE has added polymer-enhanced sodium bentonite clay to our standard GCL to provide superior coal ash resistance.



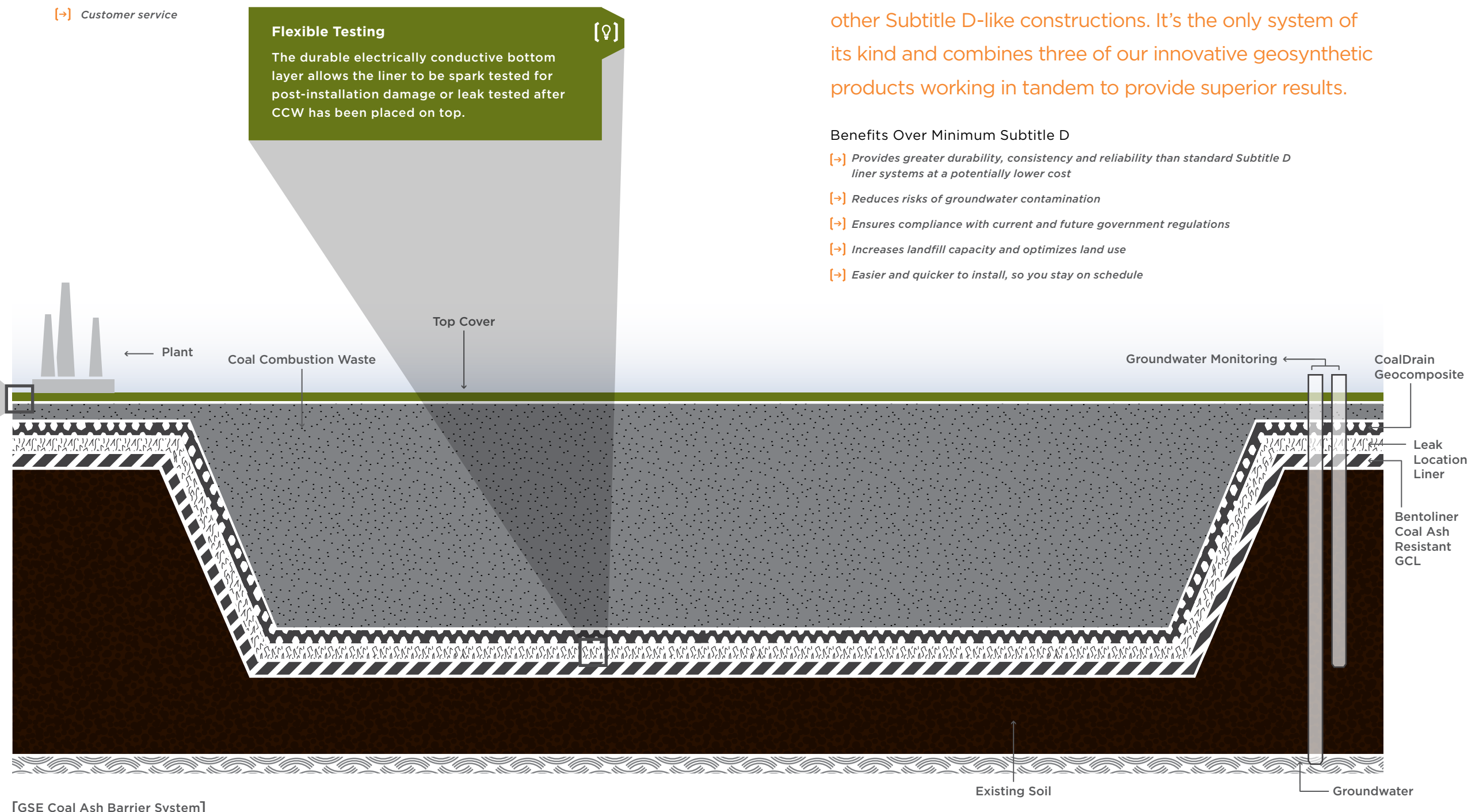
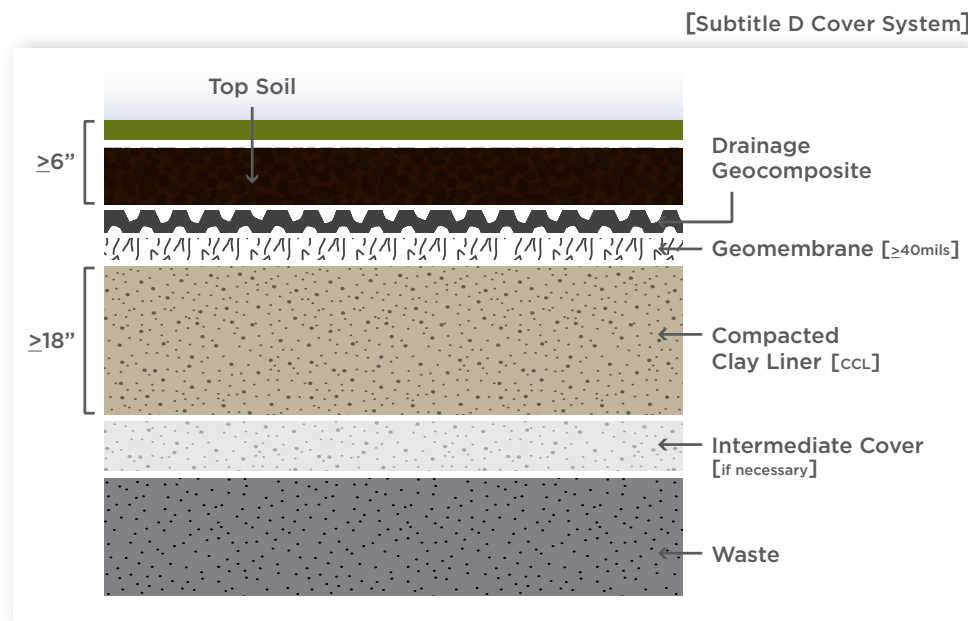
### Leak Location Liner

This is a high performance co-extruded high-density polyethylene (HDPE) geomembrane specifically designed for use in the most stringent applications. This product has a UV-stabilized upper white surface that reflects light, enables damage detection and reduces wrinkles and subgrade desiccation in addition to an electrically conductive bottom layer, which can be tested for leaks in a safe, effective and cost-efficient manner. It decreases risks of leaks and mitigates groundwater impact.



### CoalDrain Geocomposite

CoalDrain replaces the filter layer and the leachate collection layer in a typical Subtitle D liner system. It uses a highly engineered geotextile that has been developed specifically for CCRs. The filter and drainage performance of CoalDrain has been verified through laboratory and field-testing.



Ohio State University's Olentangy River Wetland Research Park, in collaboration with the department of Civil and Environmental Engineering and Geodetic Science, conducted a laboratory and field-testing program to evaluate the performance of GSE CoalDrain geocomposite. In this test program, CoalDrain was tested under the exact same conditions as would exist in an actual CCW disposal site. The research performed by Ohio State University showed that GSE Coal Ash Drainage geocomposite effectively allowed for unimpeded flow of liquids and did not let coal ash particles pass through.

### CoalDrain Benefits

- [→] Replaces up to two feet of earthen material for filtering and drainage
- [→] Easier and less costly to install than earthen material
- [→] Because large equipment and natural materials are not used for installation, damage to the liner system is greatly reduced
- [→] More accurate estimation of installation cost
- [→] Always meets requirements, while earthen material can be inconsistent
- [→] Lower quality assurance costs
- [→] An engineered system that is more effective and consistent than natural systems and other geocomposites with no clogging or piping
- [→] Installation is less time consuming than natural materials and is not impeded by weather conditions, so you stay on schedule
- [→] Installation interferes less with the surrounding community

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, value and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

### Worldwide Locations

Our business is global because our customers are global. Headquartered in the U.S. and with manufacturing facilities in Chile, Germany, Thailand and Egypt, as well as engineering and sales professionals in numerous countries, GSE can provide local service to our worldwide customers.

- [→] Houston - United States
- [→] Hamburg - Germany
- [→] Bangkok - Thailand
- [→] Cairo - Egypt
- [→] Santiago - Chile

