# IN SITU THERMAL TREATMENT


**Rapid, permanent destruction of contaminants in high- and low-permeability strata to achieve remedial goals.**

HGL offers a full array of services to safely and efficiently investigate and remediate sites where in situ thermal remediation (ISTR) represents an optimal cleanup technology. For mature sites, ISTR is often the best technology to address recalcitrant high-mass, principal threat wastes, often contained within low permeability units. HGL's technical approach to perform Remedial Investigation (RI) or Pre-Design Investigations (PDI) at potential ISTR sites includes the use of innovative technologies such as membrane interface probe (MIP) in concert with Environmental Visualization System (EVS) software to delineate thermal treatment zones (TTZs) and estimate contaminant mass and of passive flux meters (PFMs) to calculate the rate of diffusive flux (back diffusion) from low permeability strata to support the use of ISTR over other technologies. In addition, HGL uses CompFlow, a state-of-the-art numerical modeling tool that solves 3D multiphase (water/gas/oil or water/DNAPL/dissolved contaminants) compositional flow and transport problems, including heat transport, that occur in complex porous soil as well as in discretely fractured rock. CompFlow also conducts subsurface thermal energy storage/recovery and geothermal simulations that can evaluate the feasibility of implementing ISTR technologies. HGL's ISTR expertise encompasses the following:

- RI/FS, PDI to Support ISTR Technology Selection/ Implementation
- Performance-based ISTR Design Plans and Specifications
- Complex Flow and Transport Modeling
- ISTR Implementation in Challenging Environments
- Field Engineering, Quality Assurance (QA), Quality Control (QC), and Safety Oversight

## HGL DISTINCTIONS

**Unique experience conducting ISTR in challenging environments, including the first ISTR project completed under active railroad tracks.**

**Completed the first two ISTR design plans and specifications for EPA Region 3 under the DES contract.**

**Proven success executing ISTR projects effectively and safely, achieving remedial goals.**

**Demonstrated experience performing ISTR pilot studies.**

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## CASE STUDIES

Former Brandywine DRMO NPL Site, Brandywine, MD – Between 2006 and 2020 HGL executed FFP performance-based task orders under contract with the USACE Omaha District involving RD/RA activities for a 21-acre TCE plume extending from the Joint Base Andrews-controlled former Brandywine DRMO Superfund site into an adjacent residential area. HGL delineated potential DNAPL source zones and the dissolved plume during PDI efforts. HGL conducted a contaminant rebound study in response to monitoring data to identify areas of back diffusion from low permeability layers. HGL subsequently employed MIP and PFMs to identify the areas of highest contaminant mass and to estimate the mass of TCE in the source area. HGL quantified the rate of diffusive flux from the underlying aquitard to estimate the source longevity/remediation time frame and validate the need for an aggressive source reduction remedy. HGL summarized this information in a supplemental RI and prepared an FS, PP, and ROD for the final ERH remedy.

HGL worked with a thermal vendor to design, construct, and operate a large-scale ERH system to address the 49,000-CY source of residual TCE DNAPL and 1,4-DCB in the underlying aquitard. Traversed by active railroad tracks, water and sewer utilities, and a public road, the TTZ employed two electrode designs that required 58 sheet pile electrodes and 43 bored electrode pairs to address site constraints. The RD included plans and specifications to temporarily re-route and restore the sewer line, to install shut-off valves, and to remove and replace the water main within the TTZ. Conduits were installed under the rail lines via CSX-mandated jack-and-bore drilling methods to make the necessary connections between the power drop, TTZ, and two ERH equipment compounds located on either side of the tracks. Heating under the railroad tracks necessitated design of a complex real-time monitoring system to assess subsidence and confirm that track alignment did not deviate from uniformity beyond tolerances in Federal Railroad Administration regulations. To accomplish this, an Automated Motorized Total Station and mirror survey prism system was installed that used a laser to measure movement of prisms mounted on the steel rail of the tracks during the operational period. The ERH system operated for 206 days and applied a total of 277 kWh per CY of soil.

Power, energy, voltage, amperage, resistance, and subsurface temperatures were routinely monitored to assess the efficiency of the ERH system and optimize system performance. ERH treatment resulted in a 97.2% reduction of TCE and a 99.5% reduction of 1,4-DCB, achieving remedial goals and removing 1,716 lbs of contaminant mass.

In 2018, 2019, and 2020, HGL received "Exceptional" CPARS ratings from USACE Omaha District across all categories (quality, schedule, cost control, management, and regulatory compliance) for this project. *"Of all the remedial efforts I've been involved with, this one has been the most successful considering the monumental effort expended to overcome various administrative, legal, permitting, and stakeholder concerns."* Jennifer Grimm, USACE Geologist. *"The final stage of active remediation has been successfully completed! A long journey with MANY regulatory, legal and railroad issues have been met and overcome. The effort needed to successfully guide this project to completion cannot be overstated."* Doug Simpleman, Assessing Official, USACE. *"What they did at Brandywine was incredible!"* Jim Cummings, Technology Assessment Branch, OSRTI, EPA.

Work at the site was presented as part of the April 2019 Successful Applications for Thermal Treatment panel at DCHWS east. In 2022, HGL received the "2022 Superior Achievement Award" presented annually by the AAEES to the best project entered in its Excellence in Environmental Engineering and Science™ Awards Nationwide Competition. The project is highlighted in the January-February 2023 Issue of *The Military Engineer*.

Ellis Property Superfund Site, Evesham Township, NJ – The Site, located in a residential area, was originally used as a dairy farm until 1968, when approximately 4 of the 36 acres were used for drum reconditioning operations until the late 1970s. Under contract with USACE Kansas City District, for U.S. EPA Region 2, HGL and its ISTT subcontractor prepared a site-specific ISTT system design and extensive planning documents per the project design drawings and specifications to heat the subsurface and achieve cleanup to an objective of 1 mg/kg TCE throughout the 57,200-square-ft (61,500-CY) TTZ. The ERH system was constructed in 8 months, involving the installation of 209 electrodes to treatment depths between 24 and 41 ft. Work included removing 340 ft of sheet piles installed to approximately 25 ft bgs along the north side of the treatment area; these efforts required a critical lift using a 100-ton hydraulic lift crane. Perimeter air monitoring was performed for the duration of preconstruction, ISTT operations, and site restoration activities Once active, system operations were reconfigured periodically to control the amount and location of energy input to the TTZ. The system operated for 192 days from February 2, 2022, through August 12, 2022, when confirmatory sampling verified that cleanup criteria had been met at all locations. Cumulative energy applied was 8,715,199 kWh, representing 97% of the design energy, with a maximum subsurface temperature of 99.13°C achieved. USACE provided an interim PPQ with "Very Good" and "Exceptional" ratings across all categories.

Arrowhead Plating Superfund Site, Montross, VA; Jackson Ceramix Superfund Site, Falls Creek, PA – Under the EPA RAC2 contract, HGL performed RI/PDI activities and prepared the FSs evaluating ISTT at these sites. Because DNAPL (TCE) and high levels of 1,4-dioxane were present under an occupied building at Arrowhead, ISTT (ERH), became the final remedy for this area in the ROD Amendment. At Jackson Ceramix, the DNAPL (PCE) source area was present around and beneath active railroad tracks. HGL completed additional PDI activities and ISTT remedial design engineering plans and specifications for both sites under CLIN 1 of the EPA DES contract. PDI activities at Jackson Ceramix investigated saprolite and bedrock for the presence of DNAPL to vertically delineate the TTZ. The 100% RD specifications, reviewed by USACE and approved by EPA, include >20 sections across 5 divisions. Design criteria and components include health and safety; MW installation and abandonment and electrode installation and abandonment; vapor and liquid extraction, treatment, and discharge; ISTT construction and operation, and site restoration. EPA put the designs out to bid among RES contractors. HGL continues to provide implementation support to EPA as the designs are executed under the RES contract.

Sioux Army Depot, Sidney, NE – HGL conducted a pilot study to test an innovative application of ERH at sub-steaming temperatures to remediate explosive compounds in vadose zone soil. The purpose of the ERH was to increase the soil temperature and thereby the rate of hydrolysis to levels that allow for effective degradation. The objectives of the pilot study were to provide proof-of-concept field testing for this application. The pilot study targeted a circle with a 40-ft radius to a depth of 70 ft where explosives concentrations were elevated throughout the vadose zone. The design included 19 electrodes and 4 TMPs distributed throughout the TTZ of 5,000 square ft (14,000 CY). The electrodes were constructed with a water drip system to prevent the soil from drying during heating, as moisture is required for the hydrolysis reaction. A total of 857,737 kWh of energy was applied to the treatment volume over the course of the 188-day pilot study to heat the soil to an average 80°C. HGL, USACE, and ERH subcontractor TRS Group, Inc., were invited by EPA to present the results of this first-of-its-kind project on the EPA CLU-IN platform in April 2020: https://clu-in.org/conf/tio/DCHWS7/.

**For additional information on HGL's ISTT capabilities, contact Ken Cottrell at 703-736-4563, kcottrell@hgl.com**