TerraTherm

Source Zone Treatment

CVOCs and DNAPL

TERRATHERM
a Cascade Company

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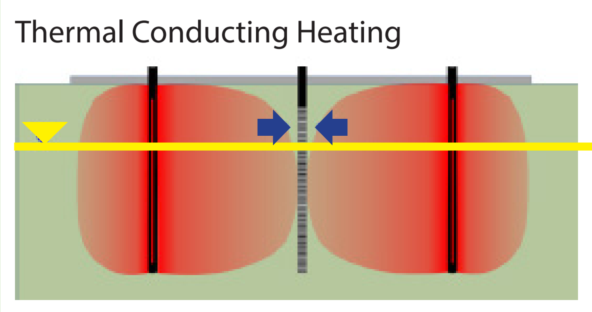
TerraTherm

OUR THERMAL TECHNOLOGIES

Overview

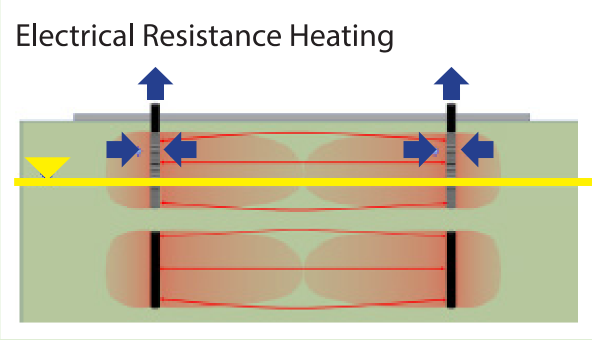
We offer low, moderate, and high temperature thermal remediation solutions using Thermal Conduction Heating (TCH). Depending upon the targeted contaminants, remedial goals, and timeframe, we can select the optimal thermal treatment approach to reliably and safely cleanup your site. Chemicals TCH can treat include VOCs, CVOCs, BTEX, SVOCs, PAHs, PCB, dioxins, PFAS, and even mercury. It is also an ideal remedy for LNAPL and DNAPL.



TCH is a straightforward heating technology that relies on one of the least varying properties of soil and bedrock, thermal conductivity. During TCH, heat radiating from hot thermal wells warms the treatment volume to the desired remedial temperature over a period of 60 to 90 days. Heating can target, 35, 80, 100, 250, 350, 400°C, or any temperature in between.

TCH is ideal for both in situ soil and groundwater remediation and the ex-situ treatment of stockpiled soil and sediments and has been applied successfully to depths of over 150 feet below grade.

Electrical Resistance Heating (ERH) is highly effective at treating contaminants that require heating to 100°C, including: VOCs, BTEX, CVOCs, Naphthalene's, Chlorobenzenes, and LNAPL. ERH works by applying alternating voltages and current (AC) to electrodes placed in a grid pattern across the treatment area. As the soil matrix resists the flow of current between the electrodes, the treatment volume is heated by Joule heating. The upper temperature limit for ERH is 100°C. If the water is boiled off, heating stops.



Our ERH systems are specially engineered and designed to safely address a wide range of conditions that may be present at your site, including working in, around, and beneath buildings and infrastructure. We use discrete length electrodes and power control strategies customized to your site's geology.

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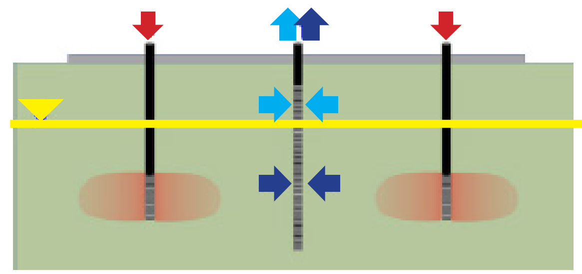
Steam Enhanced Extraction (SEE) is the most cost-effective way to heat the subsurface. Simple energy transfer from the injected steam to the subsurface intervals and flowing through produces the desired heating results.

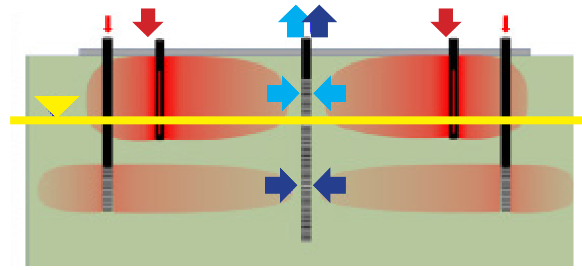
SEE is not an ideal technology for treating low permeability lithologies containing clay or silts. However, because SEE can effectively heat permeable units, it is an ideal heating technology for saturated geologic units with moderate to high groundwater flux. Typical contaminants targeted with SEE include: VOCs, BTEX, CVOCs, Naphthalene's, Chlorobenzenes, and LNAPL.

For sites with complex geologies and both low and high permeability and high groundwater flux, we combine heating technologies to provide the optimized solution to effectively and thoroughly heat and treat the targeted interval. Typical technology combinations include the use of ERH or TCH in shallower tight soils and SEE in an underlying flowing aquifer, as well as using ERH to selectively target interbedded silty or clayey units and SEE to target the permeable sands.

Steam Enhanced Extraction



Combinations



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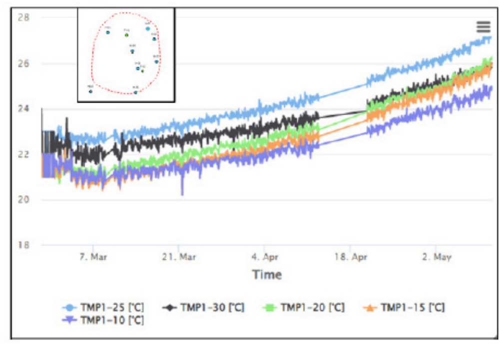
Low Temperature Thermal

Overview

Our low temperature thermal technology utilizes simple, inexpensive, and easy to install electrically powered heaters to gradually and gently heat soil and water.

We use our highly controllable low temperature thermal technology to uniformly heat the targeted soil and water to the desired temperature range to enhance the rate of biotic or abiotic chemical reactions:

- Increasing the temperature to between 35 and 40°C can result in a 4-fold increase in the aerobic and anaerobic biological reaction rates.
- Increasing the temperature to 60 to 90°C can increase abiotic hydrolysis reaction rates and reduce the half-lives for some CVOCs by 4 to 6 orders of magnitude (e.g., from a half life of 1,000,000 days to 10 days).
- ISCO, ISCR, and other chemistry-based injection technologies can also be enhanced by increasing the temperature.



Site Applications

- Petroleum Hydrocarbon Sites/Gas Stations (biotic destruction)
- CVOCs (biotic and abiotic destruction)

Considerations

- Low cost
- Small diameter heaters, 1 or 2-inch diameter
- Simple to install using direct push technologies
- Easy to install below grade
- Heaters can be operated unobtrusively 24/7
- Highly sustainable!

Learn More About

- **Integrated applications** with Cascade's injection and chemistries technologies for source zone and plume treatment
- **How to enhance performance** with our Low Temperature Thermal Technology to achieve:
  - More uniform treatment, and
  - Faster clean-up times

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ERH | TCH | SEE | HT | LT | IPTD®

PROJECT SNAPSHOT

Thermal Treatment of SRSNE Superfund Site

Location: Southington, CT

Client: deMaximis

Contamination: CVOCs, VOCs, DNAPL and NAPL

Volume: 57,770 cy

Goal: NAPL and Mass Removal. Targeted COC goals

Duration: 9 months of operation

Heaters: 607

Mass Removed: 496,400 lbs.

WHAT MAKES THIS PROJECT UNIQUE?

To address the large amount of contaminant mass (estimated to range between 0.5 and 1M lbs), the wellfield was operated in two phases with an overlap in the middle to minimize the size of the vapor treatment system and optimize utilization of treatment capacity. Daily peak contaminant loading ranged around 10,000 lbs./day. (IPTD®) treatment system and treatment of the contaminated soil and sediments in two sequential phases.

IMPORTANT PROJECT DETAILS

- **Approach:** A total of 607 thermal conduction heaters, 551 vapor extraction wells, and over 300 linear feet of horizontal vapor extraction wells were installed to heat and capture the volatilized contaminants. Heating and treatment were staged over two overlapping treatment periods to manage peak mass removal rates and make the design and procurement of the off-gas treatment system practical.
- **Challenges:** During the installation of the thermal wells, it was discovered that the bedrock surface elevation varied much more than previously anticipated. To address the variances in the bedrock depth, all heater borings were installed and then heaters were custom designed and fabricated the appropriate lengths.
- **Results:** The project was successfully completed with over 496,000 lbs of VOC contamination removed. This resulted in >99% reduction in COC mass and achievement of all soil cleanup goals.

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PROJECT SNAPSHOT

Remediation at Hamilton Labree Superfund Site

Location: Chehalis, WA

Client: AECOM/USACE/EPS

Contamination: PCE

Volume: ~12,000 cy

Goal: Reduce PCE concentrations in soil to less than or equal to 10 mg/kg

Duration: 5 months of operation

Electrodes/Steam Wells: 82 Electrodes in 49 locations/ 49 in 40 locations

Mass Removed: 7,795 lbs.

WHAT MAKES THIS PROJECT UNIQUE?

Site remediation was performed in two phases. The source area was remediated during phase 1, and Phase 2 addressed the large downgradient dissolved phase plume. Phase 1 was accomplished using Electrical Resistance Heating (ERH) combined with Steam Enhanced Extraction (SEE). In Phase 2, warm water from the now clean source area was used to enhance bioremediation of the downgradient plume. A stream running through the source area significantly complicated the site remediation.

IMPORTANT PROJECT DETAILS

- **Approach:** The deployment of both ERH and SEE was required to treat the heterogeneous subsurface lithology where some depth intervals were too tight for SEE and groundwater flow in other intervals too high for ERH. Once the source remediation was complete, clean and warm water was pulled through the downgradient plume to enhance the effectiveness of bioremediation approach.
- **Challenges:** The site was located between a major interstate and a service road requiring trenching and installation of utilities across the road the location of the extraction and treatment system and steam boiler. The stream running through the source area had to be isolated and insulated to protect it during heating (temperature impacts and COC migration). The ERH/SEE design included multiple steam injection and ERH intervals combined with co-located SVE wells, MPE wells, and HVEWS and an insulated vapor cover integrated into a stream re-location channel. Once Phase 1 was complete, the stream was restored to preexisting conditions.
- **Results:** After 150 days of heating, all 101 soil confirmation samples collected at various depths across the site met the thermal remediation goals (<10 mg/kg PCE). Total contaminant mass removed from the site was 7,800 lbs, which was more than triple the estimated starting mass.

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PROJECT SNAPSHOT

SEE/TCH Remediation at an Active Manufacturing Facility

Location: Florida
Client: Confidential
Contamination: CVOCs
Volume: 104,000 cy
Goal: Eliminate NAPL in the source zone.
Duration: 8 months of operation
Heaters: 413 TCH and 40 SEE Wells
Mass Removed: 4,800 lbs.

WHAT MAKES THIS PROJECT UNIQUE?

The combined TCH and SEE system was implemented to treat contaminated soils and groundwater at a site where 90% of the target treatment zone (TTZ) was located beneath a building. SEE was combined with TCH to address high permeability groundwater flow zones within a low permeability silt layer. The TTZ encompassed an area with a footprint of approximately 70,000 ft2 extending from ground surface down to a maximum depth of 55 ft bgs.

IMPORTANT PROJECT DETAILS

- **Approach:** The TTZ was located within and outside a building. 413 TCH wells and 40 SEE injection wells were installed. A Fourier Transform InfraRed (FTIR) field analytical package was used for continuous system and air discharge monitoring.
- **Challenges:** Approximately 90% of the TTZ was located beneath a building. Although the building was vacant, partition walls, drop ceilings, and existing utiliites existed within the limits of the TTZ. An Ambersorb treatment system was operated to remove 1,4-dioxane, mobilized by the thermal system.
- **Results:** The total mass removed was approximately 4,000 lbs in the vapor phase and another 800 lbs in the liquid phase and as NAPL. Biotic and abiotic processes were also found to have removed substantial amounts of mass due to the idling of the heaters and gentle low-temperature heating for several months prior to full operation.

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