Source Zone Treatment
Recalcitrant Compounds

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PFAS Remediation

OVERVIEW

Per- and polyfluoroalkyl substances (PFAS) compounds include thousands of individual chemicals that are the subject of an increasing levels of regulatory scrutiny due to their persistence and potential adverse health effects.

Much of the science with respect to their health effects, occurrence and behavior in the environment as well as how to sample and analyze for them is still being developed. In addition, clear regulatory limits for soil, water, and air have not been promulgated. This has created much uncertainty around how to characterize, treat and dispose of PFAS contaminated media.

What is certain is that thermal desorption using thermal conduction heating to raise the temperature to 350°C, is highly effective in removing PFAS from soil. This can be accomplished both in situ using In Situ Thermal Desorption (ISTD) if the PFAS treatment zone is above the water table or ex situ in above ground constructed soil piles using In Pile Thermal Desorption® (IPTD®).

RELATED EXPERIENCE

TerraTherm has successfully completed 19 high temperature PFAS related soil remediation projects using both ISTD and IPTD to treat similar recalcitrant compounds (e.g., dioxins, PCBs, PAHs).

In addition, we have completed several innovative laboratory studies demonstrating the removal of PFAS compounds from soil when it is heated to 350°C. This groundbreaking work showed that the targeted PFAS was eliminated from the soil through both mineralization (complete destruction) and evaporation of PFAS pre-cursers and degradation products.

Importantly, we have the experience required to design safe and reliable systems for the total treatment of PFAS. This includes proven effective methods for construction and heating of in situ source zones and constructed soil piles to ensure thorough heating to the required treatment temperature and safe and effective removal and treatment of the produced vapors.

When your project is ready for Total Treatment of PFAS impacted soil or media (e.g., soil fines from soil washing), and elimination of all future liability, contact our experts to explore your options for safe, effective PFAS remediation.

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High Temperature Thermal Treatment

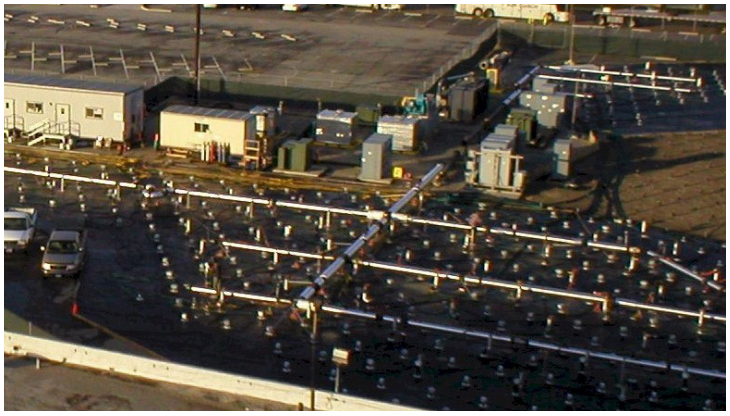
OVERVIEW

Treatment of soil impacted with high boiling point recalcitrant SVOC contaminants such as PFAS, PCBs, dioxins, and PAHs requires heating to 300 to 350°C (high temperature thermal remediation). Thermal conduction heating (TCH) is the only thermal remediation technology that can heat soil to these temperatures. TCH can even treat mercury contaminated soil.

ERH and SEE cannot achieve these temperatures or effectively treat these compounds because they both require the presence of water to deliver energy to the subsurface. Once the water is boiled off, which is required first to achieve temperatures greater than 100°C, then their heating mechanisms stop. This also means that sites with recalcitrant SVOCs that extend below the water table must include some provisions for isolating the treatment zone and controlling groundwater influx if they require high temperature thermal treatment. Continued groundwater flux will prevent achieving temperatures above 100°C.

High-temperature TCH can be performed both in situ or in specially engineered above-grade soil piles. The use of TCH to heat and treat soil piles is also known as In Pile Thermal Desorption (IPTD®), one of our patented technologies. With the application of higher temperatures (>>100°C) for treatment of SVOCs, a significant fraction of the contaminant mass may be destroyed in the soil before reaching the surface. This substantially reduces the loading and size of the treatment system. Contaminants that have not been destroyed in situ are removed from the heated soil in the vapor phase through vacuum extraction wells and subsequently treated to appropriate emission standards in a state-of-the-art, high efficiency treatment system.

We are the only thermal vendor in the world to have successfully implemented multiple high-temperature TCH projects for a variety of high boiling point contaminants such as PCBs, dioxins, PAHs, TPH, and MGP waste. To date, we have completed 19 such projects, using both in situ as well as IPTD approaches. Along the way, we have perfected the technology for safely and efficiently heating soils to high-temperatures and for extracting and treating the targeted contaminants. This gives our clients the confidence that we know what we are doing when it comes to high temperature treatment of contaminants such as PFAS, PCBs, dioxins, and PAHs, and that our high temperature designs will meet project expectations for safety, schedule, performance, and cost.



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In Pile Thermal Desorption

OVERVIEW

In Pile Thermal Desorption (IPTD®) uses thermal conduction heating (TCH) to provide ex-situ thermal remediation of soil and sediment that can be designed to treat any organic contaminant, streamlines material handling, and eliminates the need for off-site disposal of contaminated soils and sediment.

Our IPTD approach is highly flexible and easily customizable to optimize treatment of any soil volume, large or small. It involves placing contaminated soil and/or sediment within an engineered above-ground, fully covered and insulated treatment pile structure, and then heating the soil to the required temperature to destroy and/or remove the contaminants over periods of several weeks to several months. The design temperature and treatment period is dependent on the contaminants, and remedial goals. For example, treatment of soil contaminated with SVOCs such as PCBs or PFAS might require 250°C to 350°C for several months.

IPTD Treatment of Dioxin Contaminated Soil

IPTD is a good fit for shallow soil contamination, excavated soil, or IDW when off-site disposal is not an option. On-site IPTD can be a cost-effective option for total treatment of contaminants like PFAS, PCBs, dioxins, and PAHs, which importantly, eliminates the long-term liability of disposal of the soil in a landfill.

Importantly stringent soil standards can be achieved even for recalcitrant contaminants like PFAS, PCBs, dioxins, and PAHs.

We have treated soil volumes as little as 50 cy and up to 70,000 cy for our clients. The size of the pile depends on the volume of material to be treated, space available, electrical power available, and desired schedule. Over the past 20 years we have treated more than 135,000 cy of soil and sediment using IPTD and our patented TCH technology for difficult to remediate contaminants similar to PFAS such as PCBs, dioxins, and PAHs.

Largest IPTD for Treatment of Dioxins in Vietnam

Between 2012 and 2016, we implemented the largest IPTD project in the world in Da Nang Vietnam, working with USAID and the Government of Vietnam. Over 120,000 cy of soil and sediments contaminated with dioxins associated with the disposal of agent orange were successfully and safely remediated in two consecutive treatment phases using one constructed pile. Extracted vapors and liquids were effectively captured and treated and all human health and environmental discharge, worker, and resident standards were met.

PROJECT SNAPSHOT

Dioxin Treatment at Da Nang Airport - Phase 1

IPTD®

Location: Da Nang, Vietnam

Goal: 150 ppt for 2,3,7,8-TEQ

Client: USAID

Number of Heaters: 1,254

Contamination: Dioxins (2,3,7,8-TEQ)

Duration: 15 months of operation

Volume: 43,348 m^3

Pile Size: 105m by 70m by 6m

WHAT MAKES THIS PROJECT UNIQUE?

More than 49 years after the Vietnam War, during which Agent Orange was used for defoliation, a large area at the Da Nang airport remained heavily contaminated by residues of the chemicals, including dioxins such as 2,3,7,8-tetrachlorodibenzo-p- dioxin. U.S. Agency for International Development (USAID) funded and implemented this project in partnership with the Vietnam Ministry of National Defense. TerraTherm's role included design, construction, operation and decommissioning of the in-pile thermal desorption (IPTD®) treatment system and treatment of the contaminated soil and sediments in two sequential phases.

Important Project Details

- **Approach:** For Phase 1, Impacted soil was excavated and loaded into a pile the size of a football field and, 6m tall. With a required target temperature of 335°C for effective treatment, thermal conduction heating (TCH) was the only available heating technology. The soil was heated, treated, cooled and used as clean fill for airport expansion after confirmatory sampling.
- **Challenges:** Heating was observed to be slowest at the top and bottom of the pile. This prolonged the first phase, and lead to improvements of the cover design, and a revised heating strategy for Phase 2, which was completed on schedule.
- **Results:** Contaminant concentrations were reduced from a range of 4,040 to 6,880 ppt to an average of 8.9 ppt. TerraTherm received the EBJ 2018 Business Achievement Award for Project Merit in Remediation.

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PROJECT SNAPSHOT

Dioxin Treatment at Da Nang Airport - Phase 2

IPTD®

Location: Da Nang, Vietnam

Goal: 150 ppt for 2,3,7,8-TEQ

Client: USAID

Number of Heaters: 1,254

Contamination: Dioxins (2,3,7,8-TEQ)

Duration: 9 months of operation

Volume: 43,348 m^3

Pile Size: 105m by 70m by 6m

WHAT MAKES THIS PROJECT UNIQUE?

More than 49 years after the Vietnam War, during which Agent Orange was used for defoliation, a large area at the Da Nang airport remained heavily contaminated by residues of the chemicals, including dioxins such as 2,3,7,8-tetrachlorodibenzo-p- dioxin. U.S. Agency for International Development (USAID) funded and implemented this project in partnership with the Vietnam Ministry of National Defense. TerraTherm's role included design, construction, operation and decommissioning of the in-pile thermal desorption (IPTD®) treatment system and treatment of the contaminated soil and sediments tin two sequential phases.

Important Project Details

- **Approach:** For Phase 2, impacted soil was excavated and loaded into a pile the size of a football field and 6m tall. With a required target temperature of 335°C for effective treatment, thermal conduction heating (TCH) was the only available heating technology. The soil was heated, treated, cooled and used as clean fill for airport expansion after confirmatory sampling.
- **Challenges:** Heating was observed to be slowest at the top and bottom of the pile. This prolonged the first phase, and lead to improvements of the cover design, and a revised heating strategy for Phase 2, which was completed on schedule.
- **Results:** Contaminant concentrations were reduced from a range of 2,461 to an average of 0.199 ppt. TerraTherm received the EBJ 2018 Business Achievement Award for Project Merit in Remediation.

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PROJECT SNAPSHOT

TCH Treatment of Creosote and SVOCs (PCP, PAHs and Dioxins) to 350°C at former Wood Treatment Facility

High Temp TCH

Location: Alhambra, California

Client: Southern California Edison

Contamination: Petrachlorophenol, PAHs, creosote, (wood) and dioxins
Volume: 16,200 cy

Goal: Achieve mass removal and <0.065 TDEQ
Number of Heaters: 785 (two phases)

Duration: 15.5 months of operation (both phases)
Mass Removed: 870,000 lbs.

WHAT MAKES THIS PROJECT UNIQUE?

This is the largest high temperature ISTR project ever undertaken at a wood treatment site. The only alternative deemed capable of achieving the unrestricted land use goal was soil excavation followed by off-site incineration. The thermal solution was approximately 40% lower cost than the excavation/incineration alternative for this F-listed waste.

Important Project Details

- **Approach:** TerraTherm installed 785 thermal wells, including 654 heater-only and 131 heater-vacuum wells at 7 ft spacing at the site. The target temperature to achieve destruction and removal of all COCs including dioxins was 335°C.
- **Challenges:** An extensive community involvement program was undertaken by Southern California Edison and TerraTherm, and in response to community concerns and additional contingencies were included in the system design, including redundant air treatment equipment, process blowers, stack testing events and longer operator hours.
- **Results:** Over the course of the project, TerraTherm reduced mean B(a)P-E and TDEQ concentrations in soil from 30.6 mg/kg and 0.018 mg/kg (pre-treatment) to 0.059 mg/kg and 0.00011 mg/kg (posttreatment), respectively; thereby meeting the remedial goals, and resulting in a No Further Action letter from the Department of Toxic Substances Control.

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