In Situ Thermal Desorption for the Remediation of PCBs and other Hydrocarbons

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PCB Remediation Technologies

- EPA has included approximately 80 PCB* Treatment Technologies in SITE program
- GE Corporate Research & Development has evaluated numerous technologies including many in SITE program for remediation of PCBs
  - Biodegradation
  - Chemical Destruction
  - Physical/Chemical Destruction
  - Soil Washing
  - Solidification/ Stabilization
  - Solvent Extraction
  - Thermal Desorption
  - Thermal Destruction
  - Vitrification

* Includes those technologies specified as applicable for PCBs, semivolatile organic compounds, and non-specific organics.

PCB Remediation Technology Evaluation Results

- To meet GE's needs for remediation of PCBs in soils, the most appropriate alternatives are:
  - Stabilization/ containment, if permanent removal of contaminants is not required.
  - Thermal desorption for permanent removal of contaminants
- Other technologies were ruled out based on performance capabilities, safety, risk, and cost

In situ thermal desorption offers added benefit of having less impact on the surrounding community and is more cost-effective than other treatment technologies.

In Situ Thermal Desorption Technologies

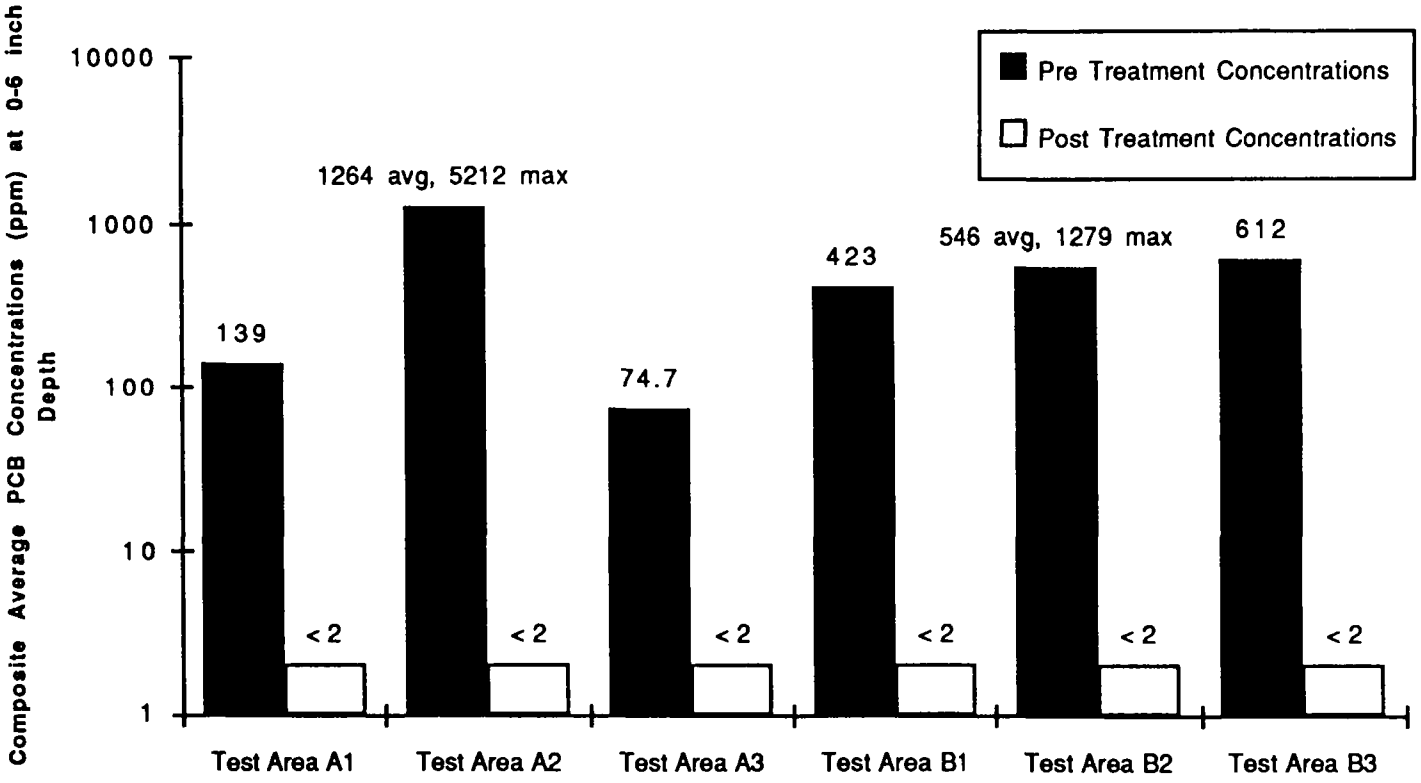
- ***In Situ*** **Thermal Desorption Using a Thermal Blanket**
  - Developed in conjunction with Shell Oil Company
  - Completed full-scale field demonstration for nationwide TSCA permit in March 1996
  - Applicable for shallow hydrocarbon contamination
- ***In Situ*** **Thermal Desorption Using Thermal Wells**
  - Previously used by Shell for oil recovery applications
  - Modification to thermal blanket system for use at deeper sites
  - Field test with nonhazardous contaminants in early Summer
  - Full- scale field demonstration planned later this year

Thermal well technology combines the use of electric downhole heaters which have been used by Shell for decades in oil recovery operations with an off-gas collection and treatment system demonstrated at full-scale for the remediation of PCBs.

In Situ Thermal Desorption using the Thermal Blanket

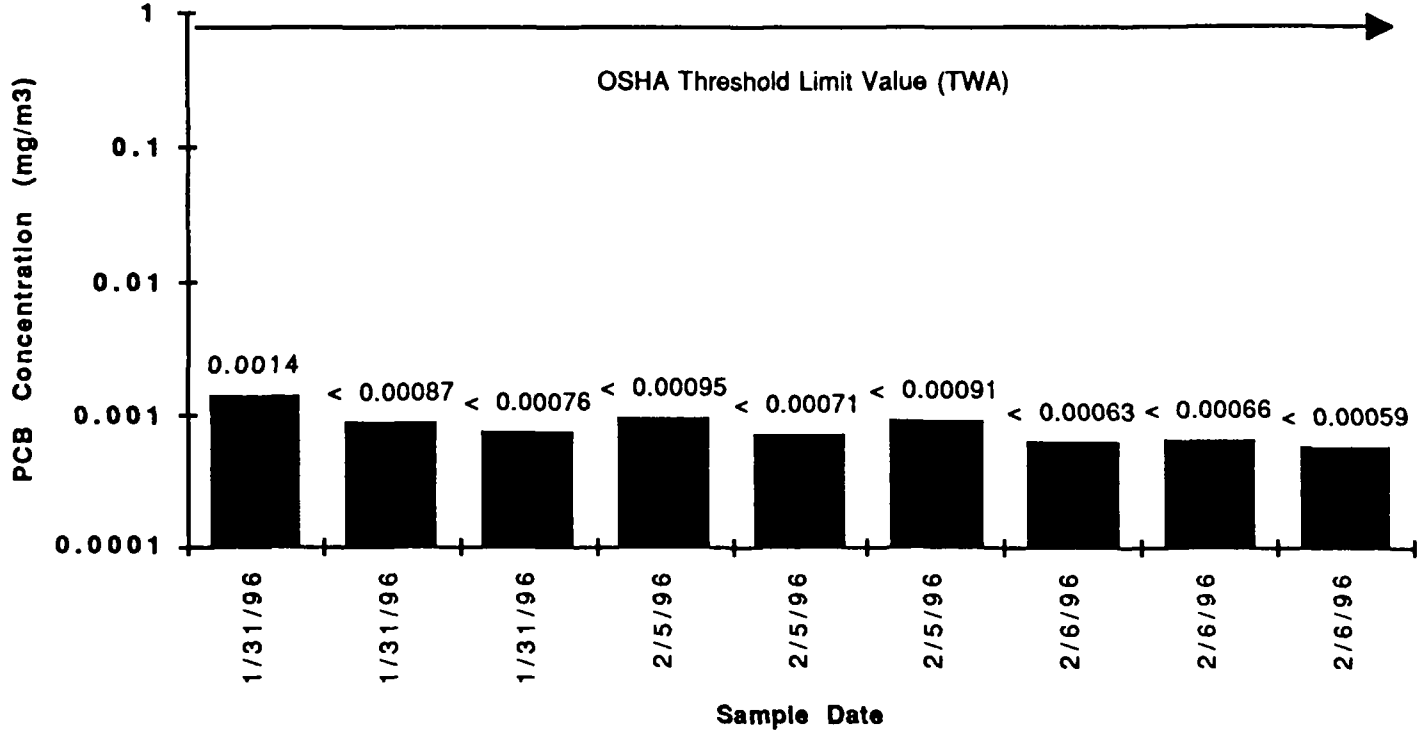
- **Target Applications**
  - Near surface contamination with PCBs or other hydrocarbons
  - Can be used in "batch mode" to treat excavated media
- **Process Design Criteria**
  - < $200 (US) per ton total cost
  - 15,000 ton nominal site with 5 year amortization of capital
  - Three trailer footprint (power trailer, process trailer, control trailer)
- **FieldTesting Results**
  - Soil cleanup standards achieved
  - Air emissions and worker exposure within regulatory guidelines
- **Status**
  - Full-scale field demonstration completed in March 1996
  - Demonstration report submitted to EPA for TSCA permitting

Thermal Blanket Soil Cleanup Results



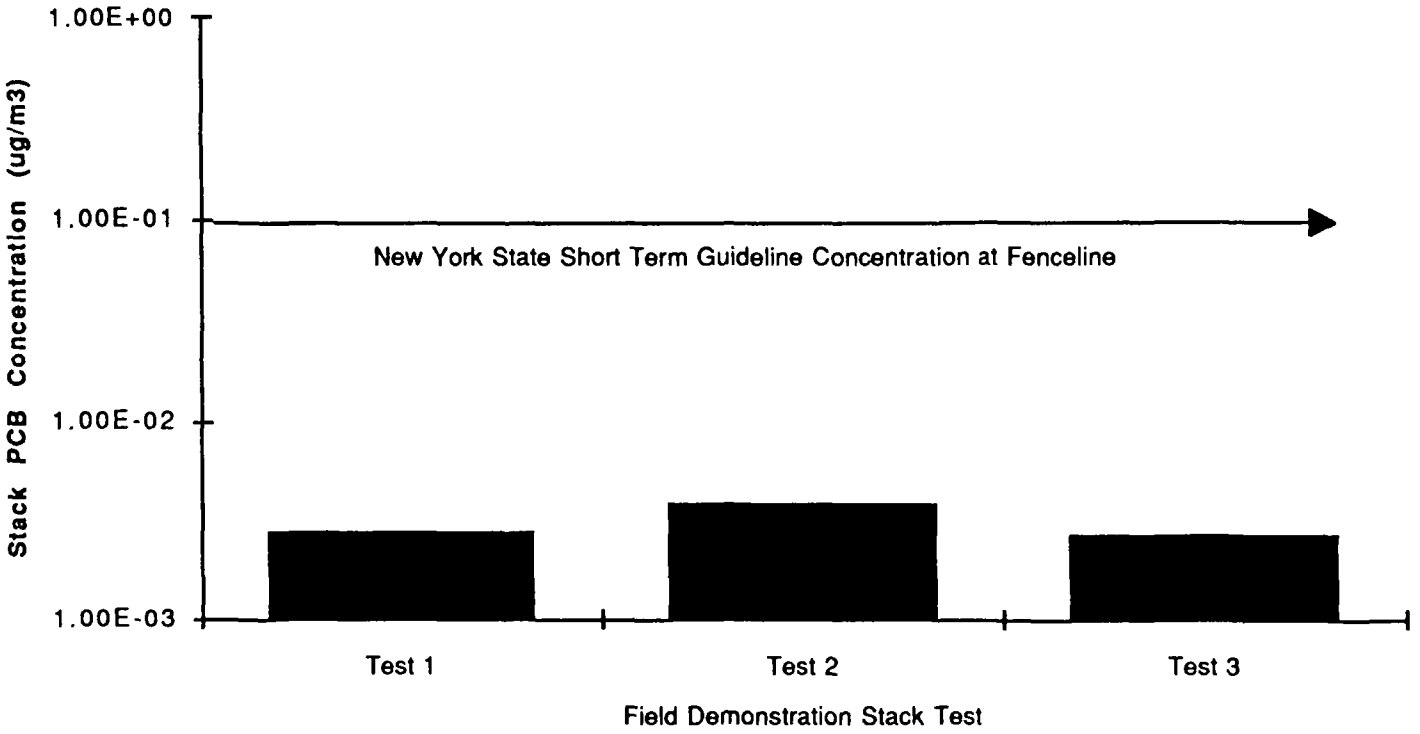
Soil cleanup objectives were achieved in each of the six tests in the grids with the highest PCB concentrations.

Thermal Blanket Ambient Air Sampling Results (NIOSH 5503)



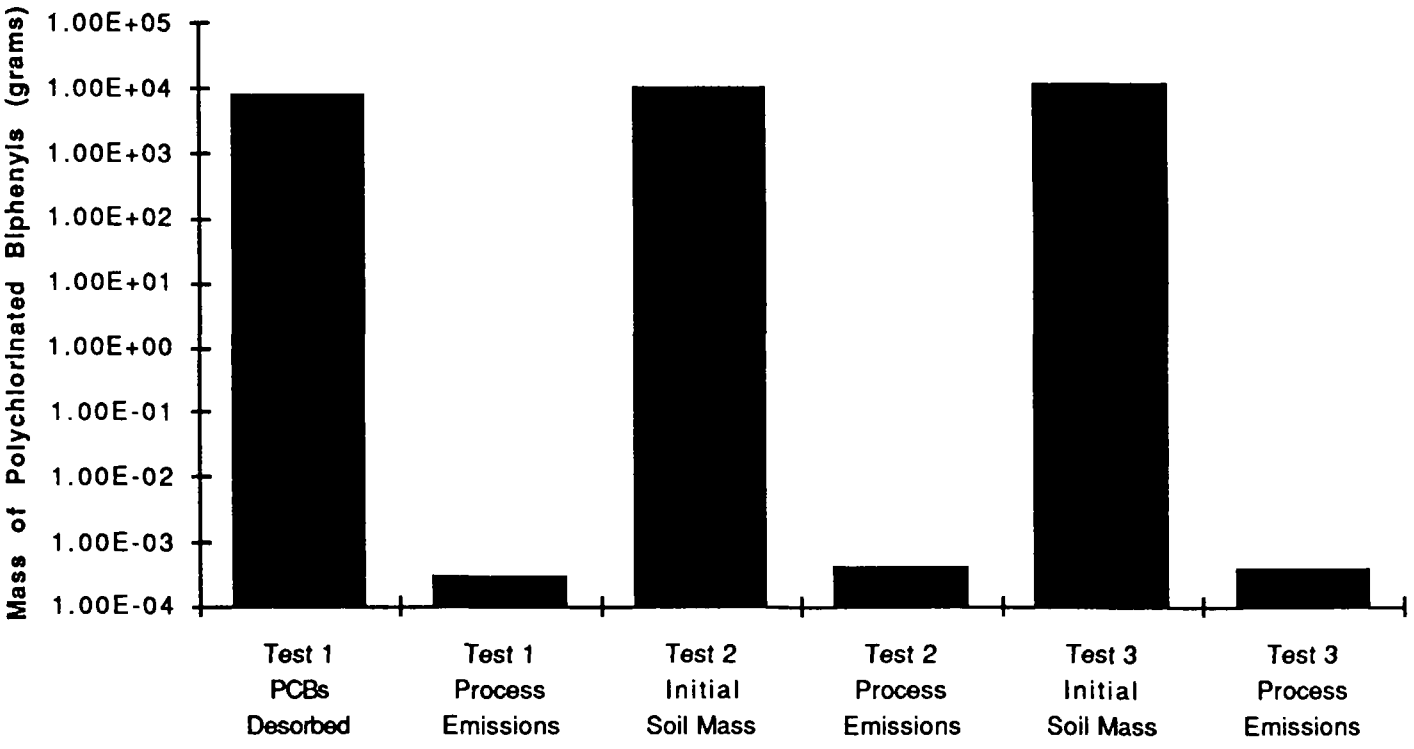
Exposure of site workers to airborne PCBs were below detection limits in all but one case and were orders of magnitude below guidelines for occupational exposure.

Thermal Blanket Stack Concentrations



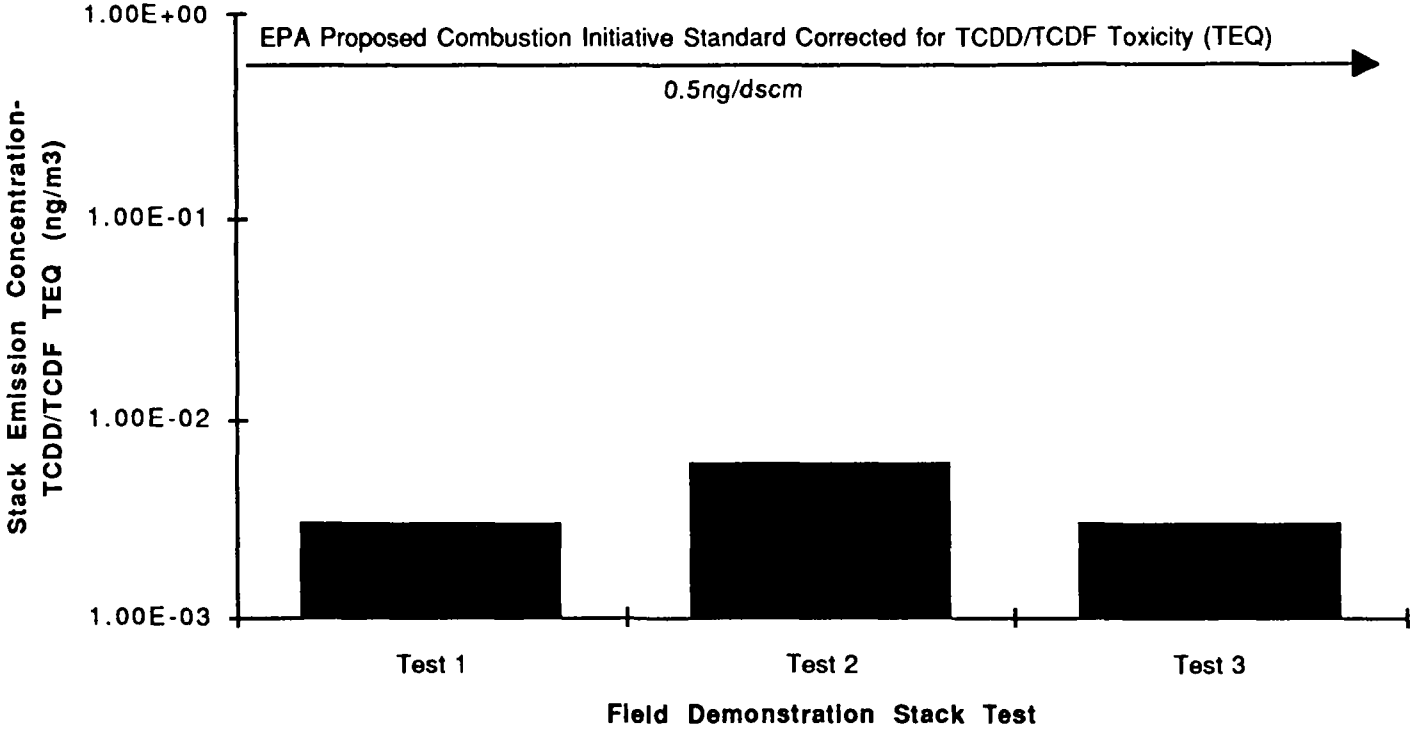
PCB concentrations measured within the stack were less than 5% of State allowed short-term guideline concentrations at the site boundary.

Thermal Blanket PCB Destruction Results



The *in situ* thermal desorption system achieved destruction efficiencies in excess of 99.9999% through the integration of the thermal blanket, thermal oxidizer, and carbon off-gas treatment process

Thermal Blanket PCDD/PCDF Emission Testing Results

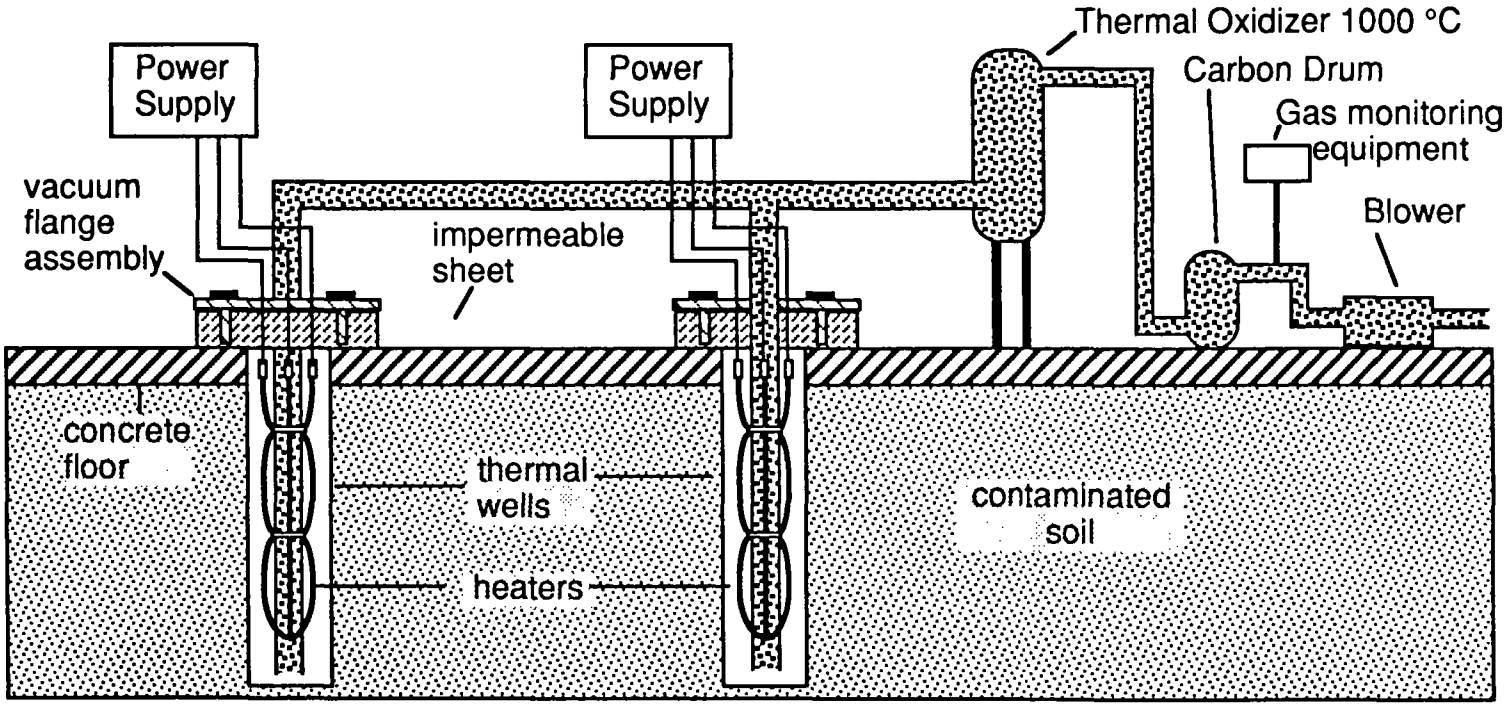


PCDD/PCDF stack concentrations were orders of magnitude below recent proposed combustion initiative guidelines. Levels at site boundary were orders of magnitude below stack concentrations.

In Situ Thermal Desorption Using Thermal Wells

- **Target Applications**
  - PCBs or other semivolatile hydrocarbons in soil or beneath buildings and VOCs in impermeable clay
  - DNAPL/ Oil Recovery
- **Process Design Criteria**
  - < $100 (US) per ton treatment costs
  - < 2 ppm residual PCBs in treated soil
  - 15,000 ton nominal site size with 5 year amortization of capital
  - Less than 6 months on site treatment time
- **Field Results**
  - Field demonstration of off-gas collection system complete
  - Performance capabilities similar to thermal blanket anticipated
- **Status**
  - Field "proof of concept" test planned for June 1996
  - Field demonstration planned in late 1996

Thermal Well System Diagram



EPA's R.S. Kerr Environmental Research Laboratory

- **Review meeting held on May 13, 1996 in Ada, Oklahoma**
  - **Thermal Blanket**
  - **Thermal Wells**
- **EPA lab personnel interested in *In Situ* Thermal Desorption Technologies**
  - **Offered to work with Shell & GE to ensure safety and evaluate effectiveness**

Collaboration of EPA scientists with Shell and GE will ensure thorough review of technology performance.

Future Plans for Thermal Wells

- Full-scale field demonstration at hazardous waste site
- Obtain nationwide TSCA permit (or equivalent under Superfund)
- Complete remediation of a hazardous waste site
- Technology available for other remediation applications

Fletcher's Paint Site is an ideal candidate for application of thermal well technology.

Thermal Wells Field Demo

- **Objectives**
  - Demonstrate ability to achieve soil cleanup requirements
  - Demonstrate complete on-site destruction of desorbed contaminants
  - Ensure adequate protection of workers and public
  - Ensure air emissions are within regulatory guidelines
  - Confirm projected economics
- **Description**
  - Thirty wells
  - Ten feet deep
  - Nominal treatment volume of 1,000 cubic yards
  - Duration approximately two months

For example, if site mobilization was initiated in September 1996, on-site heating would be complete by the end of November 1996 and post treatment confirmatory sampling could be conducted in December 1996.

Implementation of Innovative Technology at Superfund Sites

- CERCLA/NCP (as outlined in EPA 542/F-92/012) encourages use of innovative technologies if:
  - Less costly than currently available alternatives
  - Less adverse impact on public and the environment
  - Can treat more effectively than other methods
- OSWER Directive 9380.0-17 recommends:
  - Regions allow contract flexibility for innovative technology vendors
  - Regions help vendors establish pattern of reliable operation that satisfies performance standards

Thermal Wells are near commercial and meet criteria for implementation of innovative technologies.

Thermal Wells vs. NCP

- **Protection of Human Health and Environment**
  - Reduces quantity and concentration of hydrocarbons
- **Compliance with ARARs**
  - Meets or exceeds regulatory guidelines
- **Long-term Effectiveness and Permanence**
  - > 99.9999% on- site destruction of desorbed contaminants
- **Reduction of Toxicity Mobility and Volume through Treatment**
  - Soil cleanup to < 2 ppm and below readily achieved
- **Short-term Effectiveness**
  - Workers and public protected with minimal community impact
- **Implementability**
  - Off-gas collection & treatment system has been demonstrated
  - Electric downhole heaters used for decades in oil recovery
- **Cost-** Projected costs are less than other alternatives

Summary

- **Thermal Wells offer a number of advantages compared to other remedial alternatives**
  - Compact *in situ* process
    - » No excavation
    - » Dust and generation of noise is minimized
    - » Minimal community impacts & low air emissions
  - Can treat a wide range of hydrocarbon contaminants including PCBs, VOCs, and SVOCs
  - Readily achieves soil cleanup requirements
    - » < 2 ppm residual and lower if necessary to control risk
  - Complete on-site destruction of desorbed contaminants
  - Simple technology which uses commercially available components demonstrated in similar applications
  - Robust, readily treats a variety of soil types
  - Cost-effective
  - Broad applicability, not weather dependent
- **Field demonstration can be conducted without impacting remediation schedule**