Challenges of Thermal Remediation at Two Waste Oil Superfund Sites

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Solvent Recovery Services of New England

Southington, CT

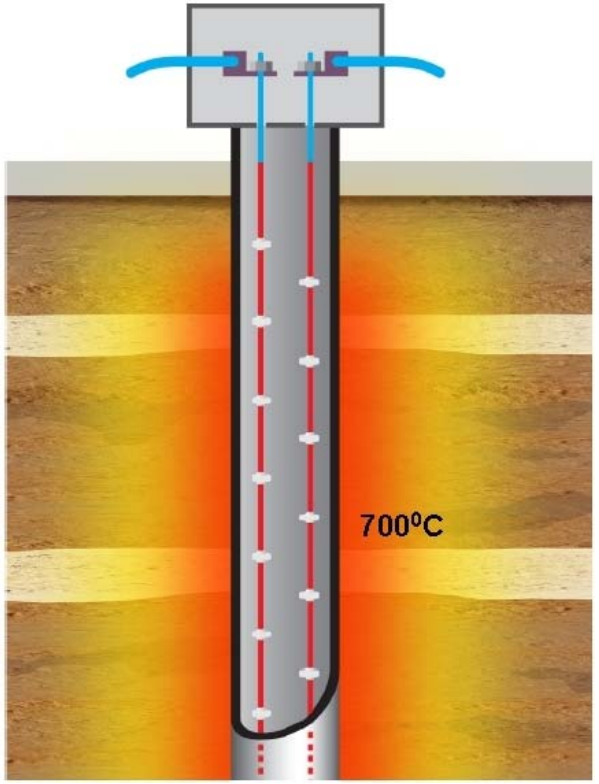
- Operated from 1955 to 1991, redistilling ~100M gallons of solvents
- NAPL ~55% TCE by weight, other CVOCs, TPH, PCBs
- 2005 ROD selected In Situ Thermal Remediation (ISTR) to recover NAPL from the overburden, Thermal Conductive Heating (TCH) chosen due to low permeability soils
- Estimated 500,000 to 2,000,000 lbs of NAPL in thermal treatment area
- Soil cleanup levels set for seven VOCs:
  - TCE, 222 mg/kg; PCE, 46 mg/kg;
  - 1,1,1- TCA, 221 mg/kg; Ethylbenzene, 59 mg/kg; Toluene, 48 mg/kg; p/m Xylene, 70 mg/kg;
  - o-Xylene, 42 mg/kg

Thermal Conductive Heating at SRSNE

- ~1.7 acres, ~ 55,000 yd3, >700 heater wells with co-located vapor extraction wells
- Estimated 496,000 pounds of VOCs recovered
  - Average soil TVOCs dropped from 2,795 mg/kg to 5.62 mg/kg
- Average 95% reduction in groundwater TVOCs

Thermal Conductive Heating

- Heat is conducted from the well into the soil, dependent on soil thermal conductivity
- Heater wells with temperature of ~ 700°C installed vertically in triangular pattern, 12 – 20 ft spacing
- Co-located vapor extraction wells
- Can be electrical or gas combustion fueled



Beede Waste Oil Suprfund Site

Plaistow, NH

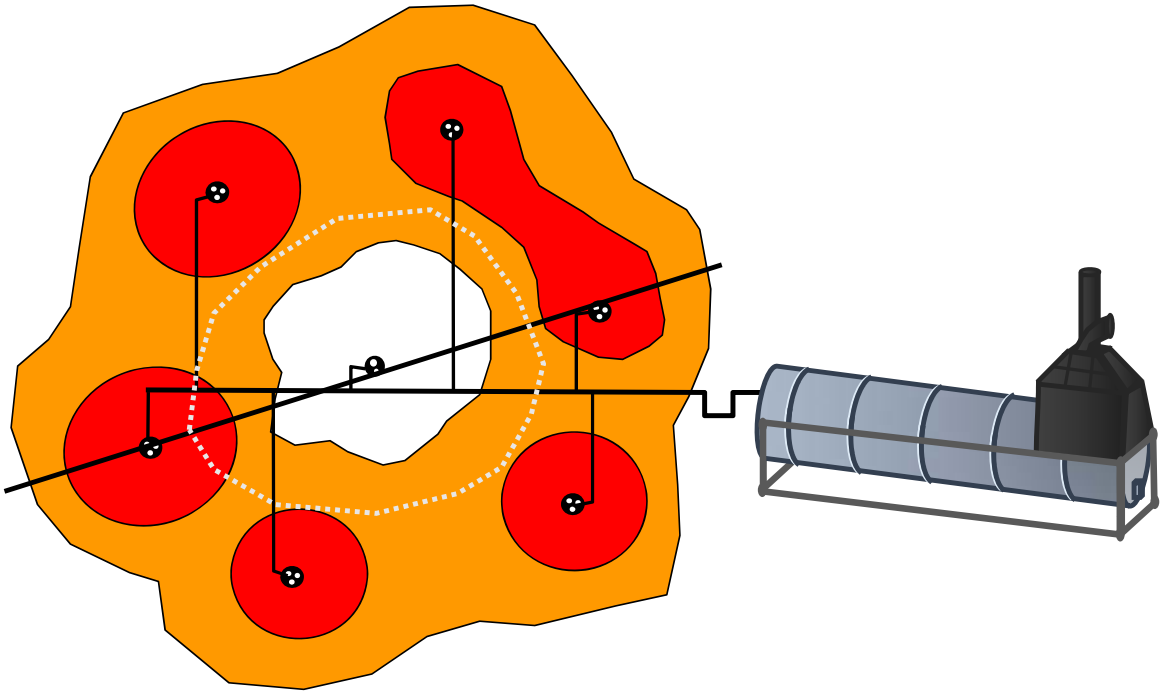
- Operated from
- Mostly petroleum hydrocarbons, mixed with chlorinated solvents
- LNAPL covered approximately 3 acres
- 90,000 gallons of LNAPL recovered by vacuum extraction from 2001 – 2005
- Steam Enhanced Extraction (SEE) chosen due to permeable sands, nearby surface water

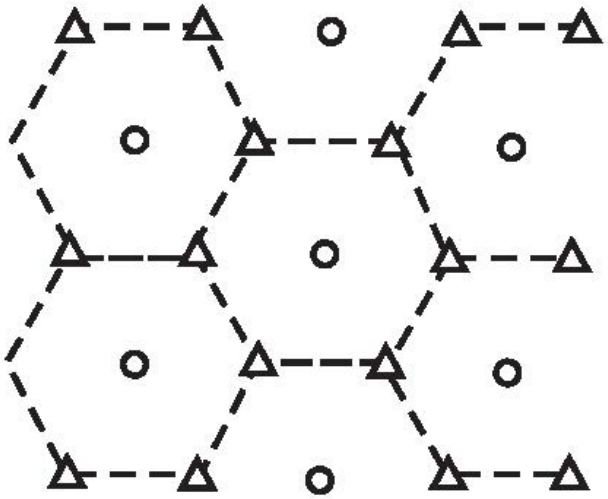
Beede Waste Oil Superfund Site

Plaistow, NH

- Phase 1 SEE: 32,841 yd^3 treated, 28.7 M lbs steam injected
- 17,278 gallons NAPL recovered, 150,066 lbs total
- Phase 2: 21,456 yd^3 treated, 66.3 M lbs steam injected
- 20,768 gallons NAPL recovered, 177,320 lbs total
- Strict soil cleanup criteria were met

Preferred Steam Injection approach: Surround NAPL with injection wells, central extraction well

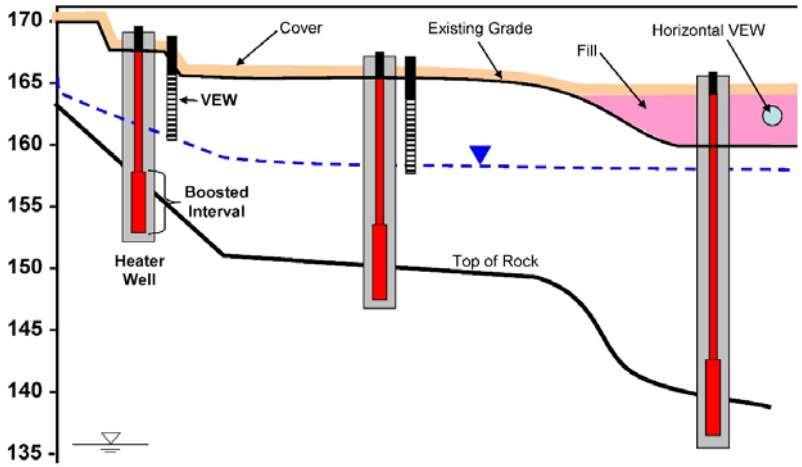




Seven Spot

Challenge: DNAPL pools atop fractured bedrock

- At the SRSNE site, DNAPL was known to be pooled on top of bedrock
- Solution:
  - Drilling protocol developed
  - Boreholes cased during drilling, casing pulled after heater can installed
  - Bottom tested for the presence of DNAPL, recovered if present



Probe boreholes & pump out any DNAPL

Challenge: Determining Top of Bedrock

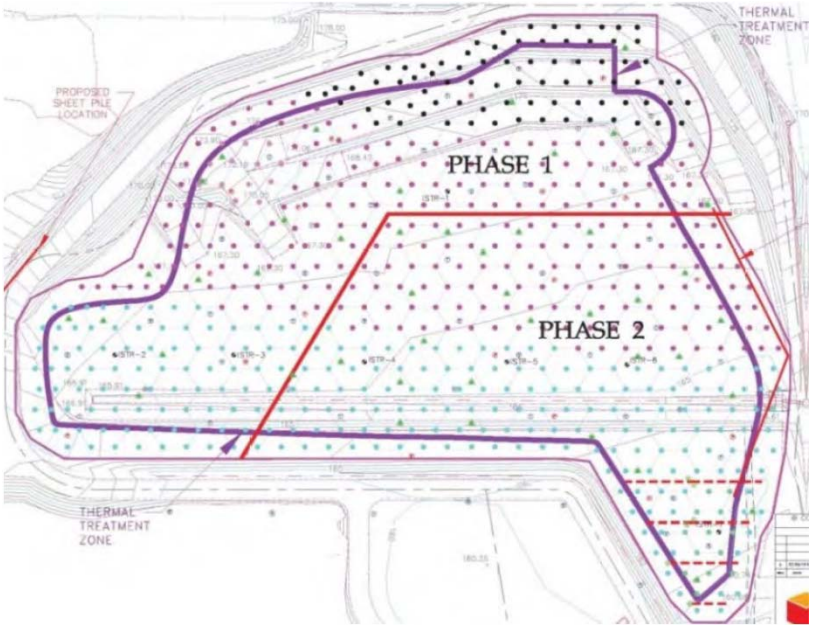
- SRSNE: DPT used for characterization, refusal met at weathered bedrock, so depth to bedrock not known
- Solution: Use sonic drilling for system installation to determine top of bedrock, increased thermal treatment area by ~ 20%, some redesign of energy systems necessary

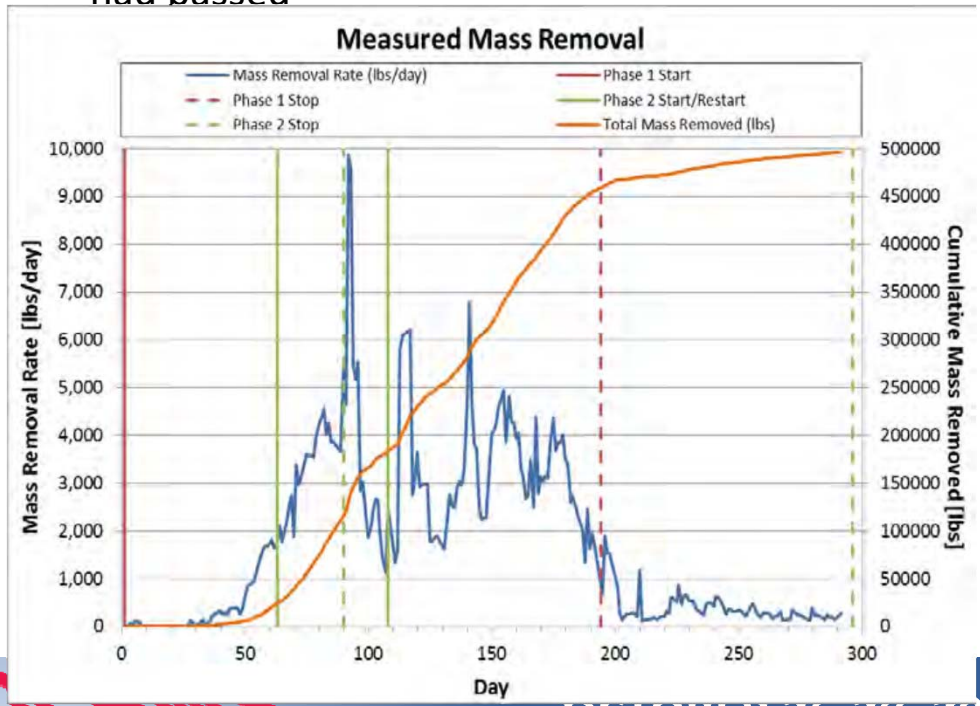
Different effluent treatment strategies

- SRSNE: maintain majority of contaminants in vapor phase & destroy in thermal oxidizer
- Beede: majority of contaminants recovered as LNAPL, vapors that didn't condense sent to thermal oxidizer

Challenge: Large site, a lot of contaminant mass

- Divide site into two phases
- Initiate heating of second phase after the peak loading to the thermox from Phase 1 had passed





Challenge: Separating Recovered Oil from Water

- At both SRSNE & Beede, NAPL was able to pass through the oil/water separator
- Caused different problems

Beede: NAPL discharged to reinjection basin

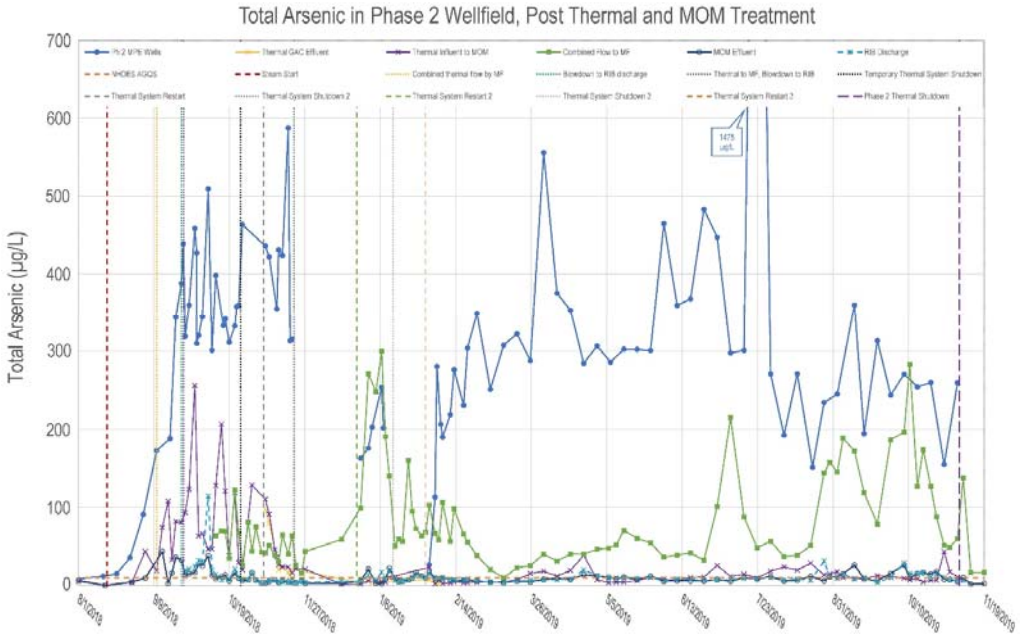
- Caused in part by biological growth-generated LNAPL-water emulsion
- Solution:
  - Add biocides
  - Adjust pH, ferric chloride addition
  - Additional organoclay filters
  - Oily soils excavated from basin for proper disposal

SRSNE: NAPL in pre-oxidizer heat exchanger

- NAPL caused combustion in pre-oxidizer heat exchanger, damaging 'daisy wheel' at oxidizer inlet
- Solution:
  - Added organoclay filter after oil-water separator
  - Added temperature sensor at oxidizer inlet
  - Reduced heat exchanger temperature set point
  - VGAC backup used for 5 weeks

Challenge: Naturally occurring arsenic and bromide

- At Beede site, As and Br mobilized by heat, recovered in groundwater
- Br concentrated by recycle to SEE system, formed bromate in advanced oxidation treatment (AOT) system
- Solution:
  - As – microfiltration, ASG media
  - Br - Water to SEE boiler bypassed Advanced Oxidation Treatment



Challenge: LNAPL Remained after Soil Criteria met

- A few MPE wells in Phase 1 at Beede still produce LNAPL (~ 30 gallons) after soil cleanup criteria met
- Positioning pump in MPE wells to provide drawdown & LNAPL recovery can be difficult
- Solution: For Phase 2, 'slurper' system used to recover LNAPL not recovered by pumping

Challenge: Winter Operation

- SRSNE: NAPL condensation under cap
  - Solution: Increase insulation of cap, increase energy to upper part of formation
- Beede: Water lines froze/damaged
  - Solution: heat tracing

Challenge: NAPL extends to Surface Water

- Beede: Sheet pile wall constructed at northern end of thermal treatment area
- Extraction wells outside wall to aid in heat & NAPL recovery

Take Away Messages

- Thermal Remediation successfully reduced soil concentrations to meet or exceed cleanup criteria
- Challenges were created by the large amounts of mass recovered
- Challenges were met so that groundwater and air discharge criteria were met at both sites

Thanks for your attention

- Special thanks to the large number of people comprising the teams at SRSNE & Beede sites that made these remediations successful
- Contact information:
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  - (580) 436-8548

Question and Answer

Q: What type of design would be most appropriate for the SNSRE and Beede Waste Oil Site?

A: Performance based design. The thermal vendors implement proprietary technologies. Use of detailed designs may result in a biddability issue or necessity for significant design changes during thermal vendor design and implementation of their technology.

Q: Why do you suspect NAPL was present in at Beede after thermal remediation was complete?

A: Site characterization efforts resulted in data gaps that did not accurately depict the treatment zone.

Q: For sites with large contaminant mass, why phase they system? Doesn't it cost more money?

A: The challenge with large contaminant mass sites is not the ability to remove the mass for the subsurface, it is the limitations of the treatment system to handle the mass. Although phasing may provide for additional costs, reducing the amount of mass into the system ensures appropriate treatment of contaminants.