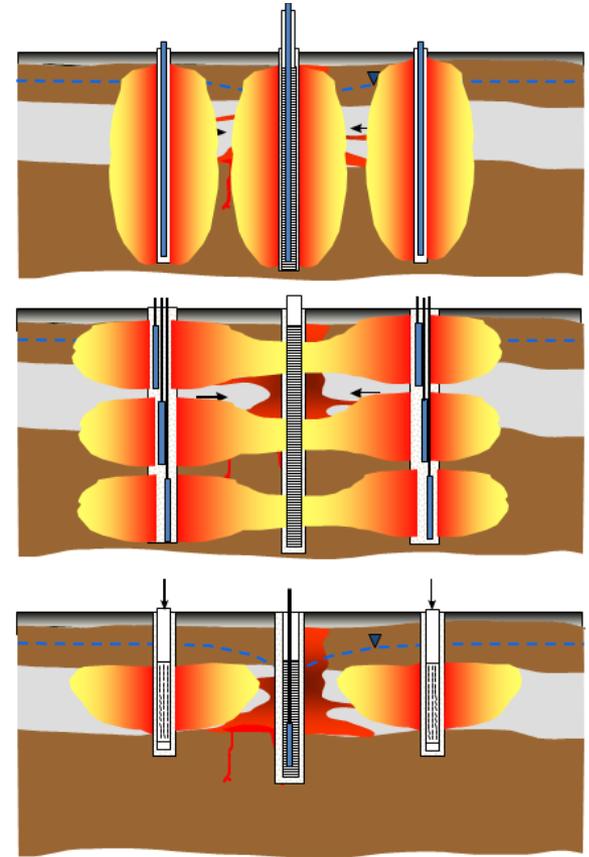


# Combining ERH and TCH for more Effective Remediation – Don't Restrict your ROD or RFP to a Single Heating Technology



Gorm Heron, Jim Galligan, Michael Dodson, Robert Flatley  
Cascade Thermal

# Facts

- 1. The cost of energy is less than 20% of the total project cost*
  - 2. Steam is 70% cheaper per BTU*
  - 3. Cost of ERH and TCH are within 15%*
  - 4. TCH used to reach more stringent goals*
- 

# So WHY?

- *Do so many RODs specify ERH?*
- *Are so many RFPs written for just one thermal technology?*



# Technologies

TCH - governed by **thermal conductivity** ( $f \sim 3$ )

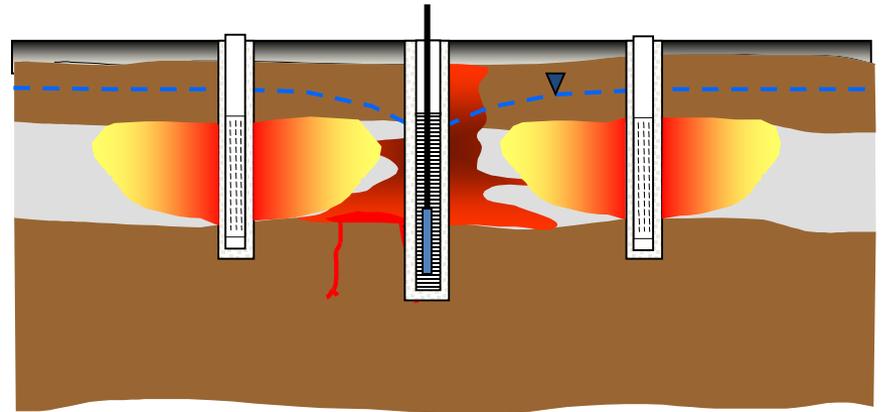
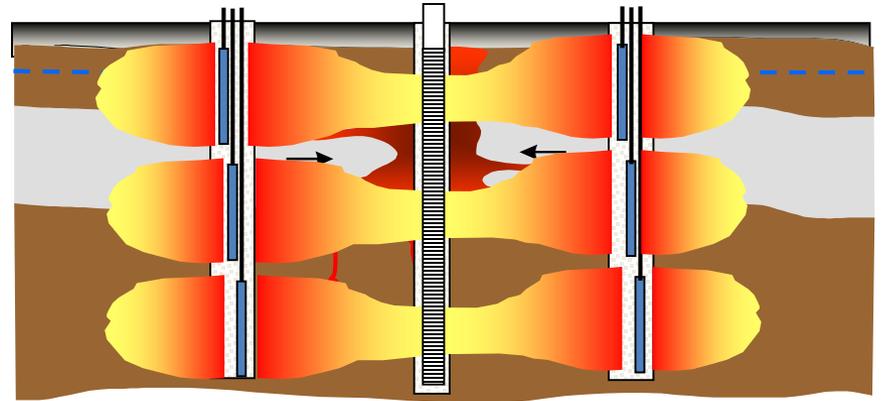
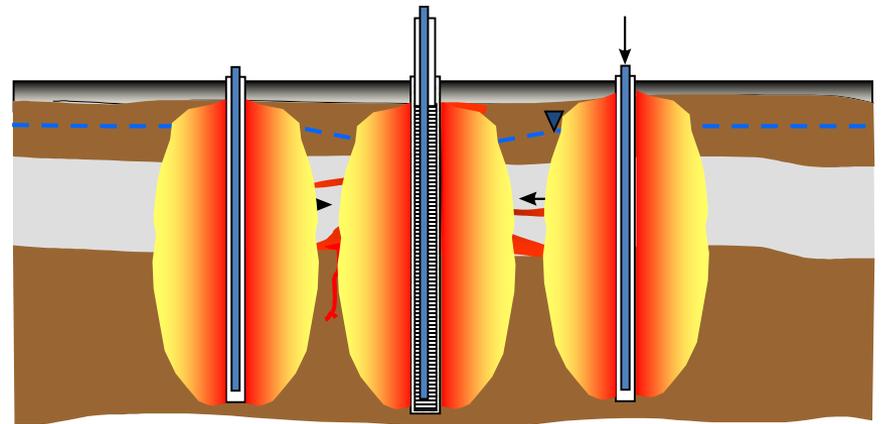
60 sites treated

ERH - governed by **electrical conductivity** ( $f \sim 200$ )

70 sites treated

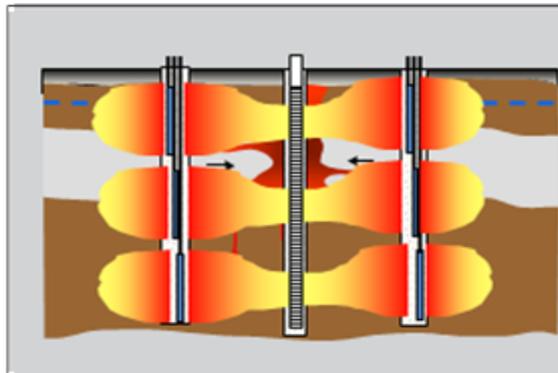
SEE - governed by **hydraulic conductivity** ( $f \sim 10^6$ )

20 sites treated



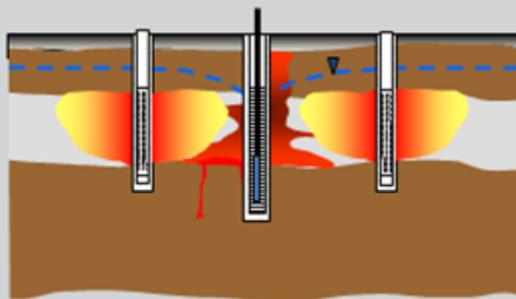
# What are the differences?

Electrical Resistance Heating  
(ERH)



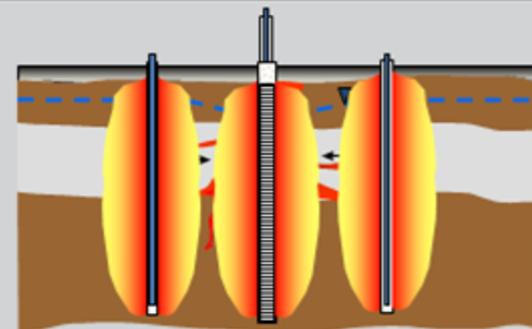
For sites with volatile or moderately volatile contaminants particularly in shallow settings.

Steam Enhanced Extraction  
(SEE)

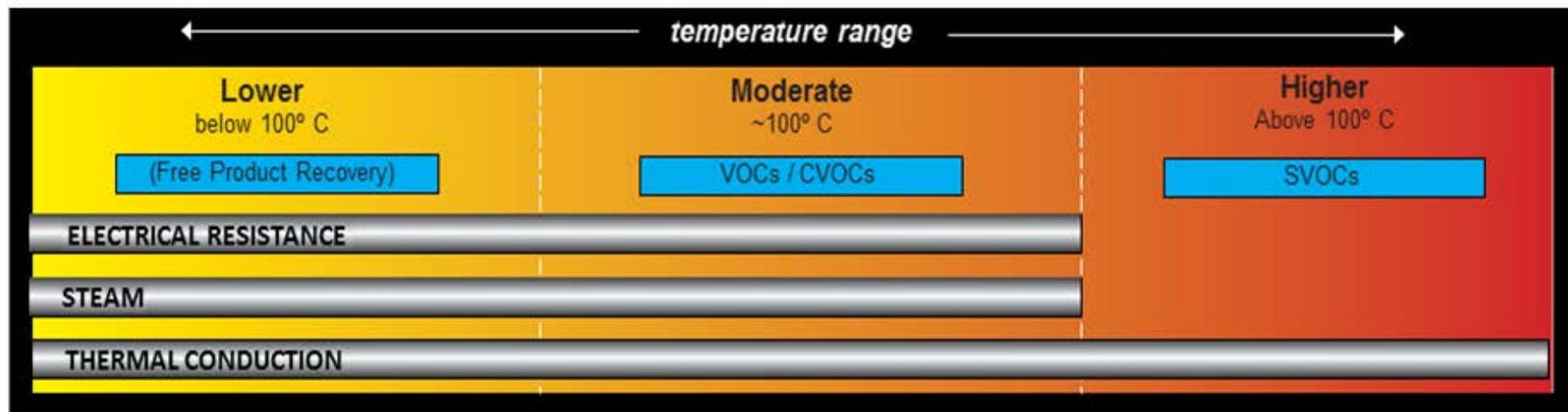


Applicable in permeable sites with significant groundwater flow and for sites with volatile or moderately volatile contaminants.

Thermal Conduction Heating  
(TCH)

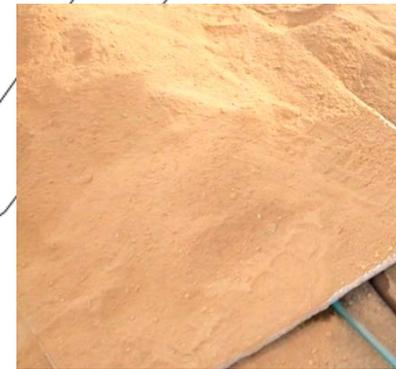
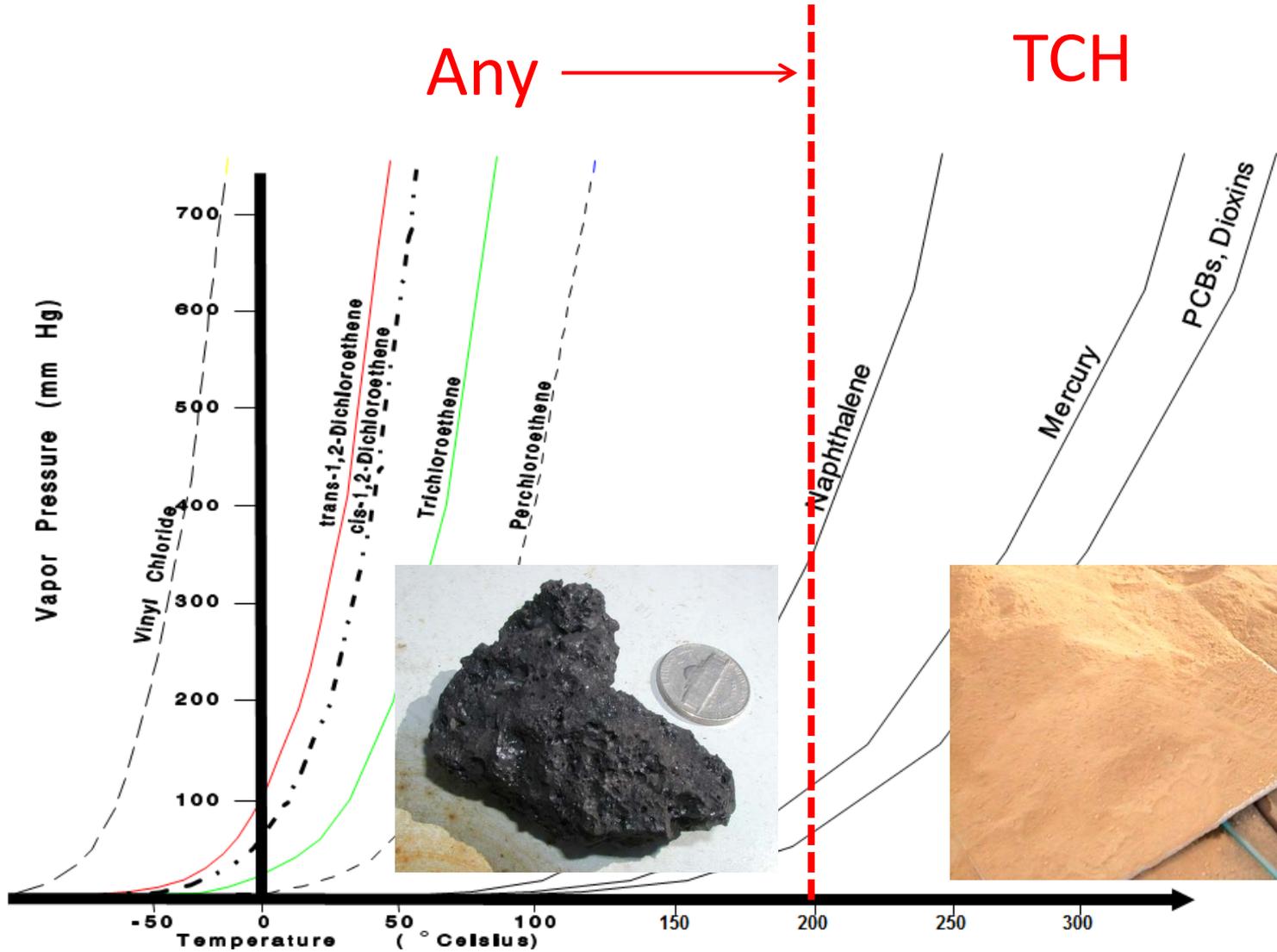


For all sites with low to moderate groundwater flow rates and either VOCs or SVOCs.



# Contaminants

Boiling points rule



## Often this is the case:

- *A combination of SEE and ERH or TCH is better and cheaper,*
- *There are things under the buildings, or utility lines that make one technology a better fit,*
- *One technology is safer, or*
- *You could get more competitive pricing if the technology was not specified*

*Cheaper – more reliable solutions!*



# Long plume? Water flows through NAPL



- *Need to keep hydraulic control*
- *Be aware of cooling*
- *Use SEE if you can*



# Groundwater Flow Impacts

## Issue:

Water flowing faster than expected

Site heating slower than predicted

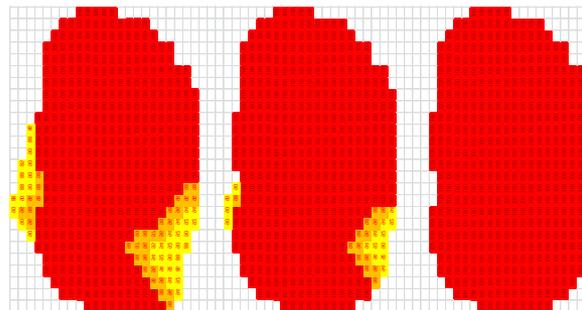


## Solution:

Cut off water

Install more heaters

Add heating capacity

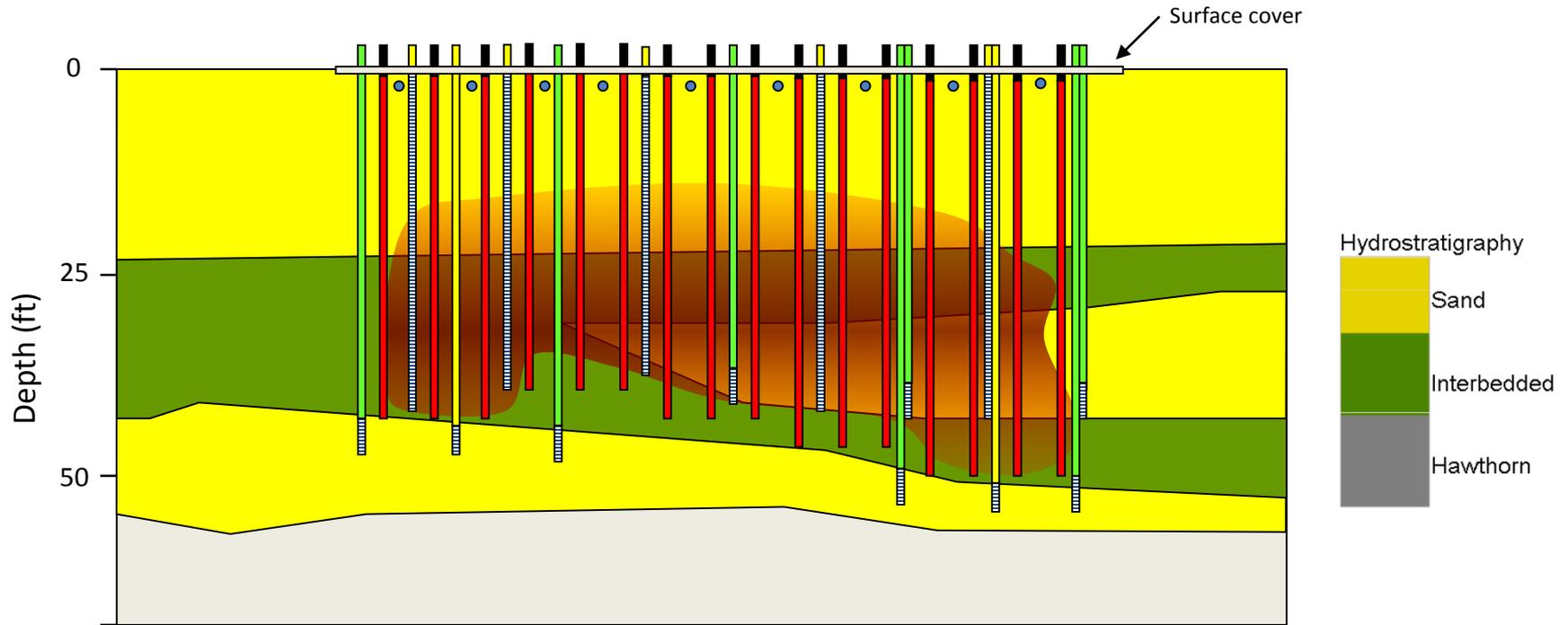


# TCH or ERH combined with Steam

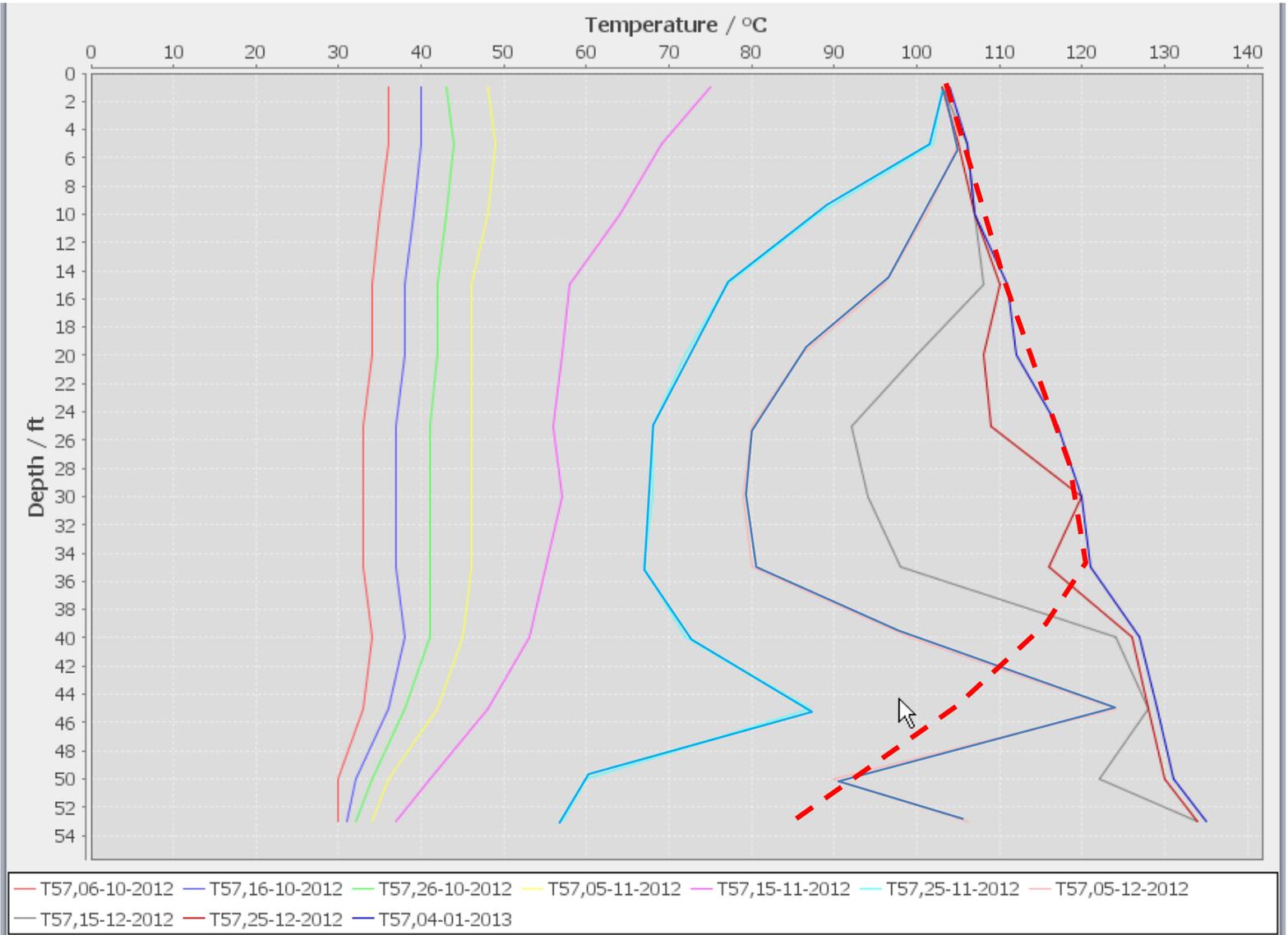
- Improves overall effectiveness
- Reduces costs
- Addresses high groundwater flux areas while TCH or ERH address low permeability areas



# TCH+SEE



# TCH+SEE

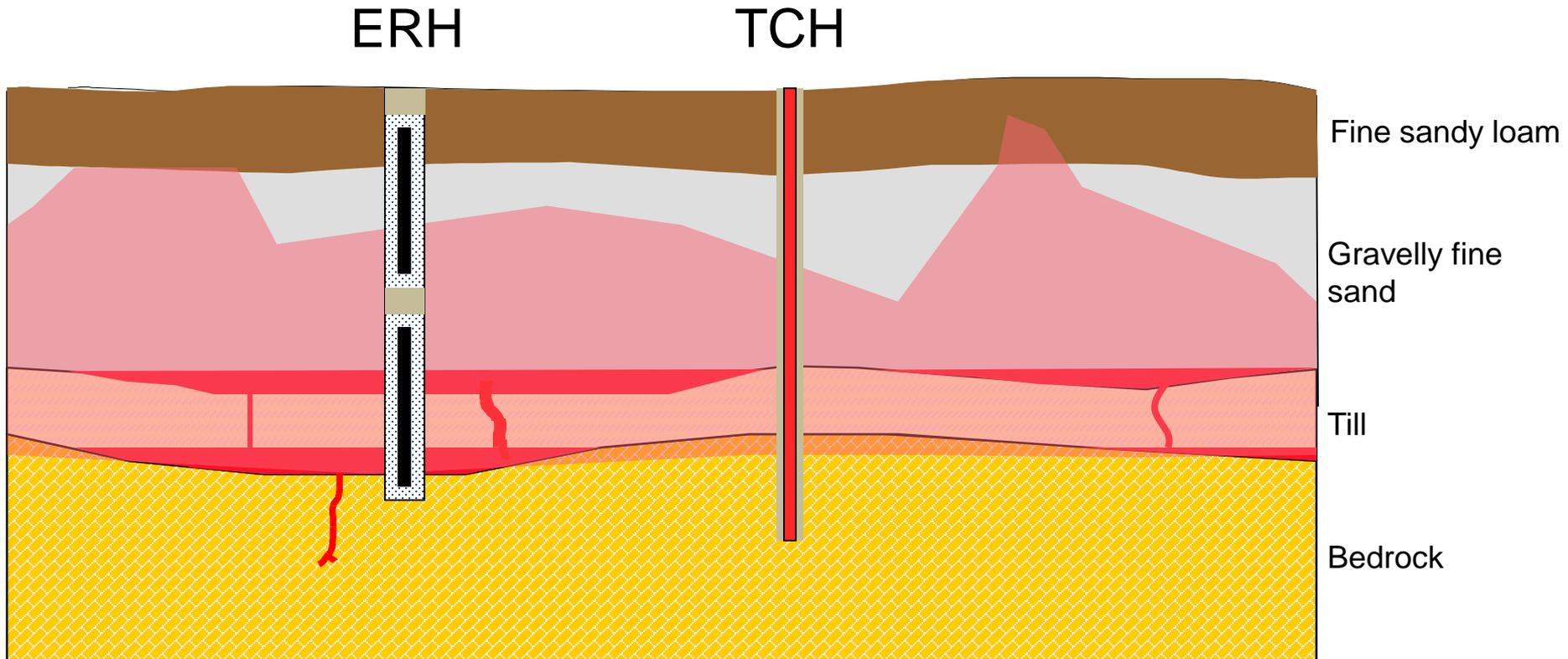


# DNAPL spreading risk

*(case: SRSNE Superfund Site, Southington CT)*



# DNAPL pooled on bedrock



# SRSNE - TCH

**230 tonnes removed  
(500,000 lbs)**





# Indiana: ERH-TCH



# Access

(case: Knullen, Denmark)



*TCH*

*Small diameter boreholes  
Drilling space limited*

# Drilling



ERH electrode  
installation (10-14")

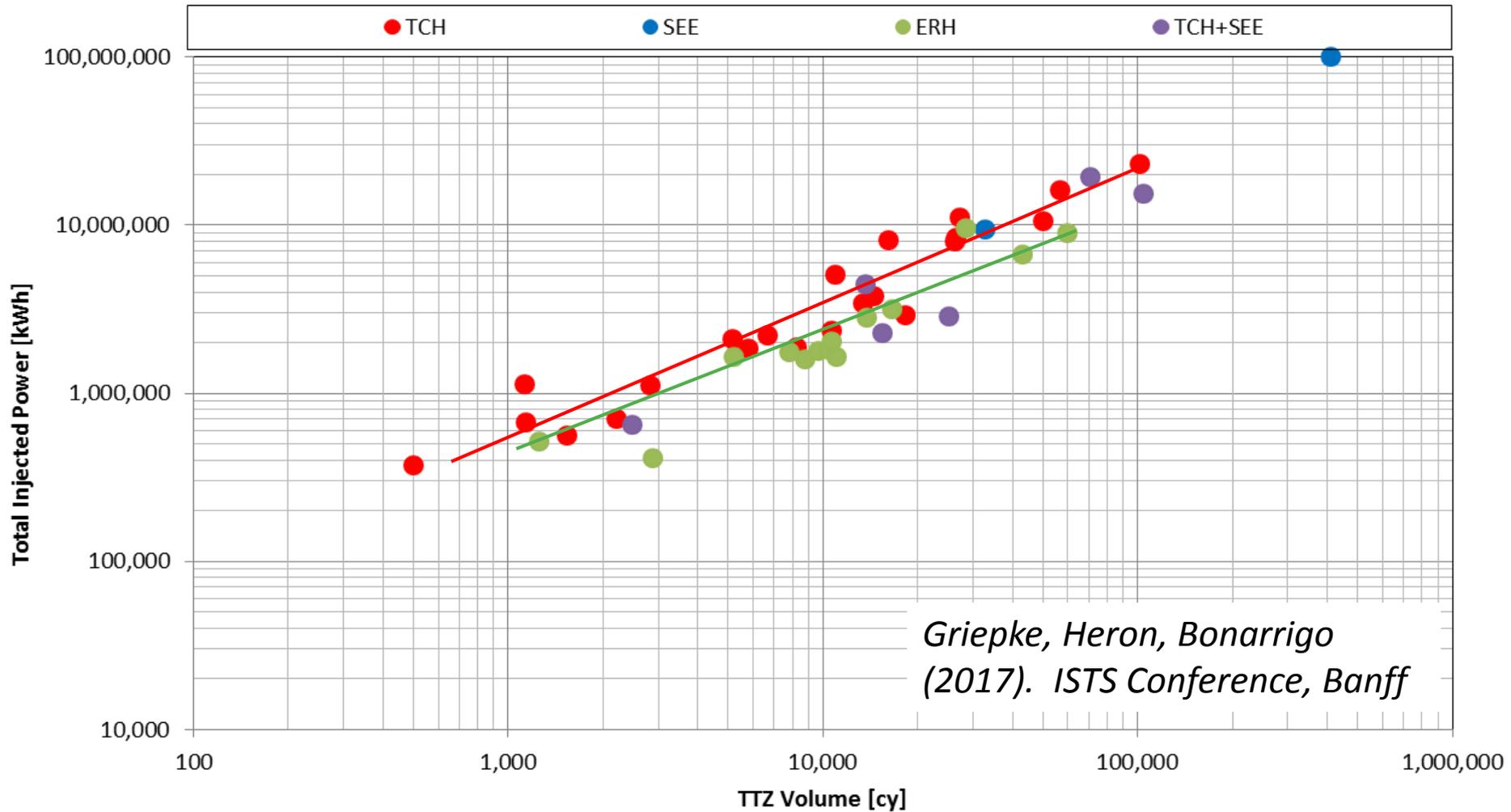
TCH heater  
installation (6-8")

# Subsurface Installation

- ERH electrode cables and lines are easier to bury than TCH heater lines



# Power usage (60 sites)



# Sweet-spot Analysis – blog post

How do you Choose between ERH, TCH and SEE?

Our clients request the most cost-effective thermal solution for their sites. Cascade has in-house Technology Centers for the implementation each of the three major *In Situ* Thermal Remediation (ISTR) technologies:

- Electrical Resistance Heating (ERH)
- Thermal Conduction Heating (TCH)
- Steam Enhanced Extraction (SEE)

So, how do we choose the best heating technology for a site? What makes one better than another, and when does it make sense to combine technologies? As the industry-leading practitioner of all three technologies, we will now answer those questions.

**Cost always rules!** Our first task is to quickly screen each site and select the best technical option. Often, one technology is clearly a superior fit. However, on many sites choosing between technologies can be a close call. In these cases, our Technology Teams prepare conceptual designs and cost estimates for multiple options and we select the option that provides the Site Owner with the best value.

Some General Rules of Thumb:

- The three technologies have different effective heating ranges:

ERH	Ambient to boiling (typically less than 120 °C)
TCH	Ambient to 400 degrees °C
SEE	Boiling (typically 100 to 120 °C)

[INSERT LINK HERE](#)

Give us:

Target volume  
Conceptual site model  
Remedial goals  
Site restrictions

Let us:

Evaluate if there are data gaps  
Propose the most cost-effective option

Together:

Implement and adapt if needed – as a team

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# Summary

