Leachate-Focused Remediation Strategy for Bunker-C Contaminated Site Using Chemical Oxidation

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Background

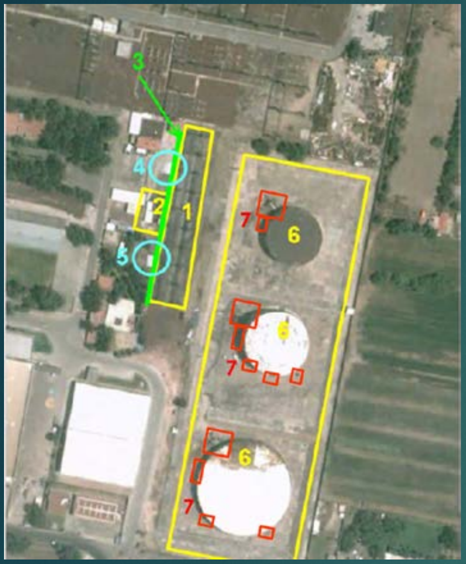
- In general remediation strategies try to achieve 3 goals:

  - Reduce risk of toxic impacts to human (or other) receptors
  - Restore usability of site according to natural vocation or urban planning
  - Reduce risk of unpleasant odors/flavors in groundwater

- Assumption 1): higher HC conc. leads to higher toxicity/leachates or other impacts (for example fertility)
- Assumption 2): reducing HC conc. to sufficiently low level will reduce or eliminate those impacts (to acceptable levels)

- What if the impacts could be reduced without concentrating on HC conc., but the impacts themselves? (save $$$)
- Treatment focused on reducing the impact (easier) than the HC conc.

Site: Bunker-C Contaminated Soil In a Thermal-Electric Plant



- Bunker-C fired thermal-electric plant (1963) converted to gas in 1990s
- Demolition of old fuel tanks, boilers, fuel distribution area to build new plant and double capacity
- Underlying soil contaminated with weathered fuel oil in sandy loam soil ~2.5 – 3% TPH (heavy oil range)

- Very low toxicity, almost null volatility, but potential to leach and contaminate ground water → aesthetic characteristics priority
- Site was actually remediated to 9,600 mg/Kg with chem-ox, but.....

- Could it have been remediated more efficiently with less cost by concentrating the remediation strategy directly at reducing soil leachate potential???
  - → objective of this study

Methods

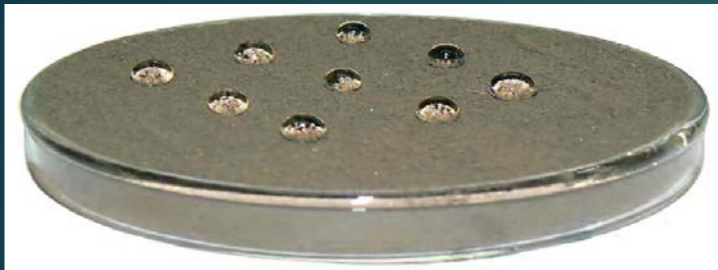
- Soil was collected from the site and water added to 30% moisture
- H_2O_2 was added (30% w/v solution) until final concentrations of: 0.1, 0.2, 0.3, 0.6 and 1.2% w/w of the reagent in soil (3 pseudo-replicates)
- Well mixed and later, air dried
- Water repellency measured by MED and WDPT as per Adams et al. 2008
- TPH measured by EPA 418.1 using PCE for solvent with calibration curve made with oil from site
- TPH measured also measured TCLP extracts

Initial Soil Conditions

Table 1. Untreated soil characteristics

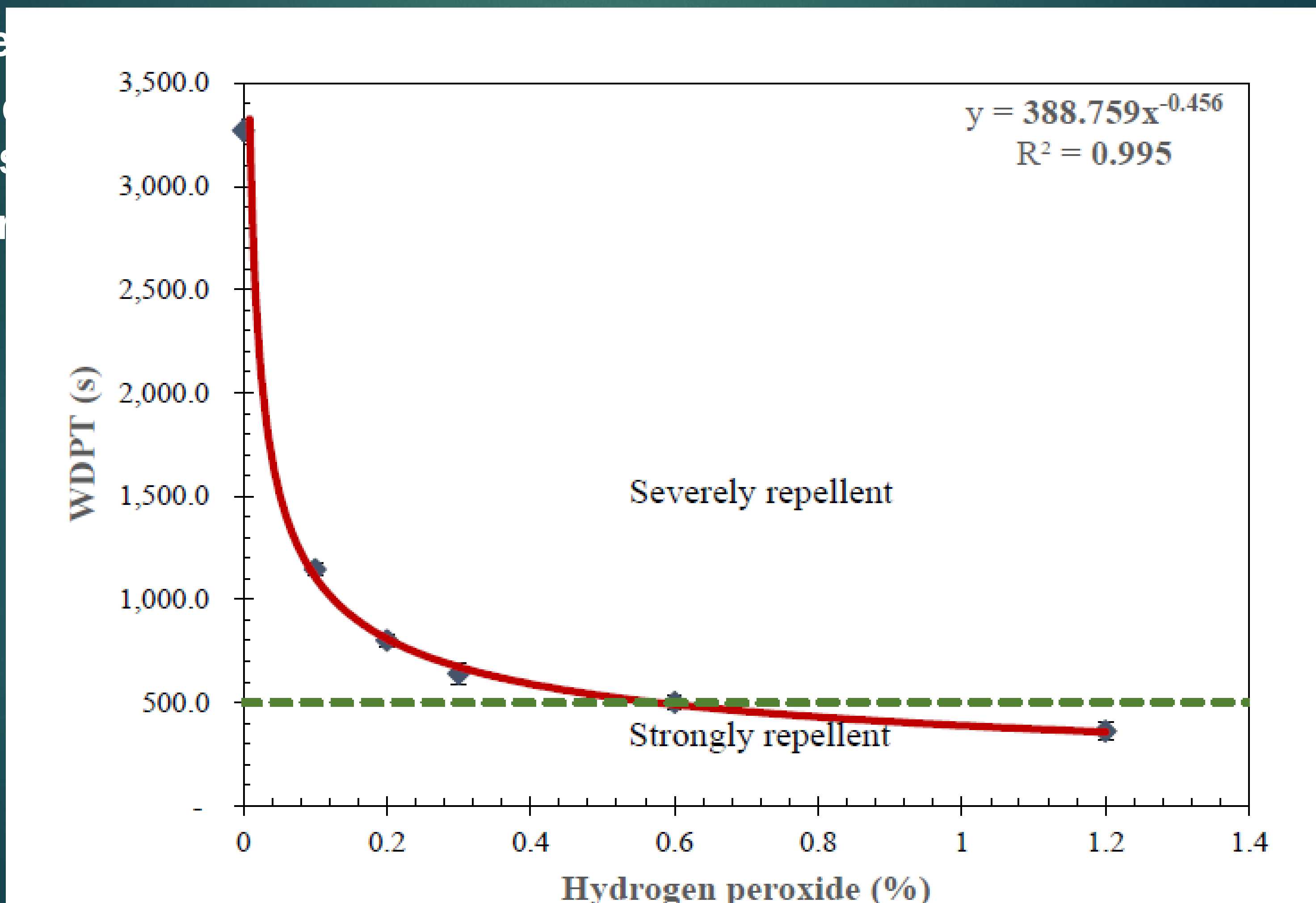
Sample	pH	SOM (%)	EC (dS/m)	Sand (%)	Clay (%)	Silt (%)	FC (%)	BD (kg/m^3)	TPH (mg/kg)	LP (mg/l)	MED10 (*M*)	WDPT (s)
$\bar{X}$	8.2	13.2	0.6	32.0	16.0	52.0	19.3	976.4	31,785	4.3	4.6	3,270
SD	0.2	0.01	0.03	0.01	0.01	0.01	0.01	0.01	423.15	0.59	-	-

SOM soil organic matter, *EC* electrical conductivity, *FC* field capacity, *BD* bulk density, *TPH t*otal petroleum hydrocarbons, *LP* leaching potential, *MED10* molarity ethanol drop in 10 seconds, *WDPT* water drop penetration time.

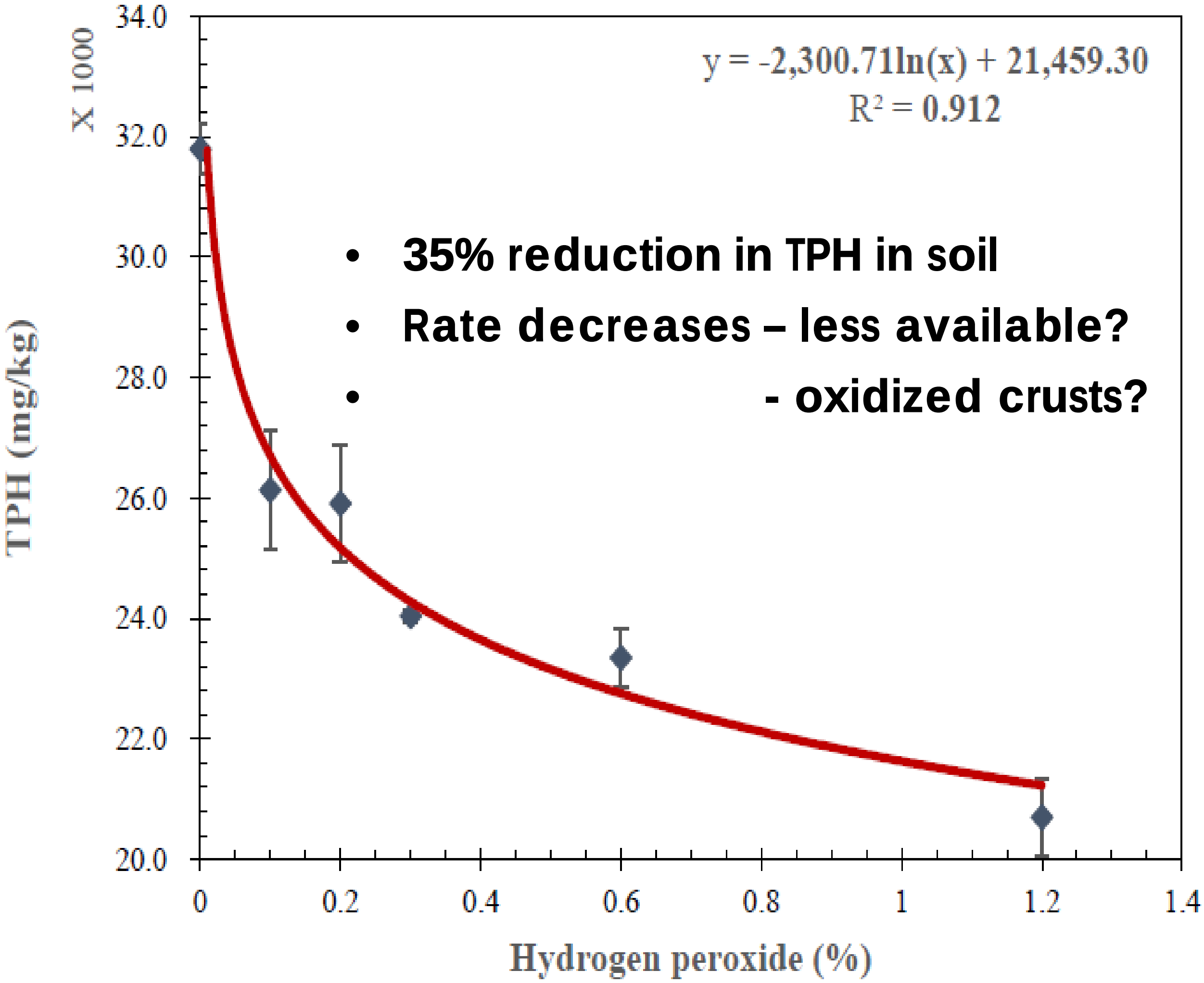


Water Repellency

- Water repellency reduces effectiveness of water based reagents
- Re
- Mo … oil in
  les
- Or … DPT)

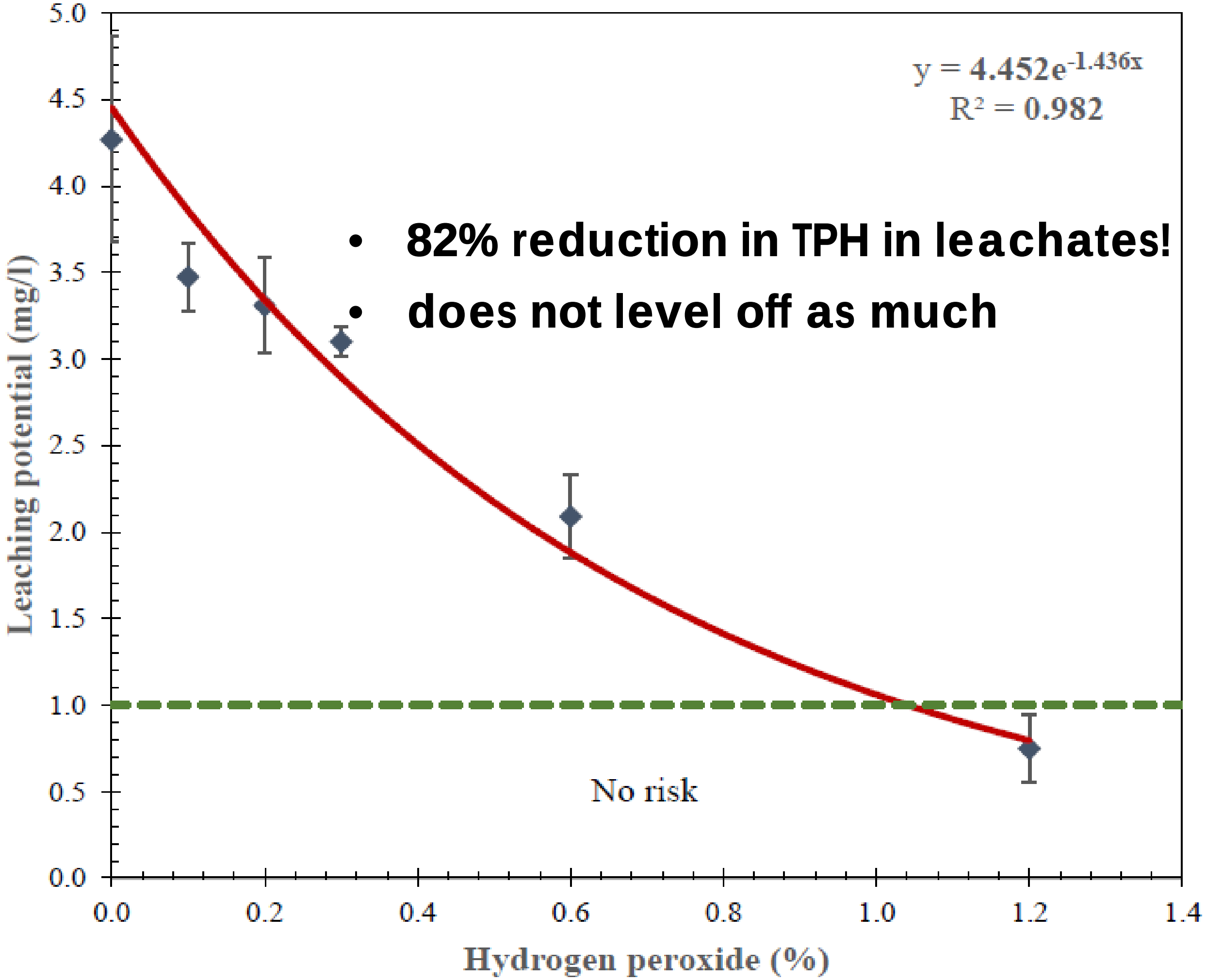


Hydrocarbon Concs. in Soil



- **35% reduction in TPH in soil**
- **Rate decreases – less available?**
- **- oxidized crusts?**

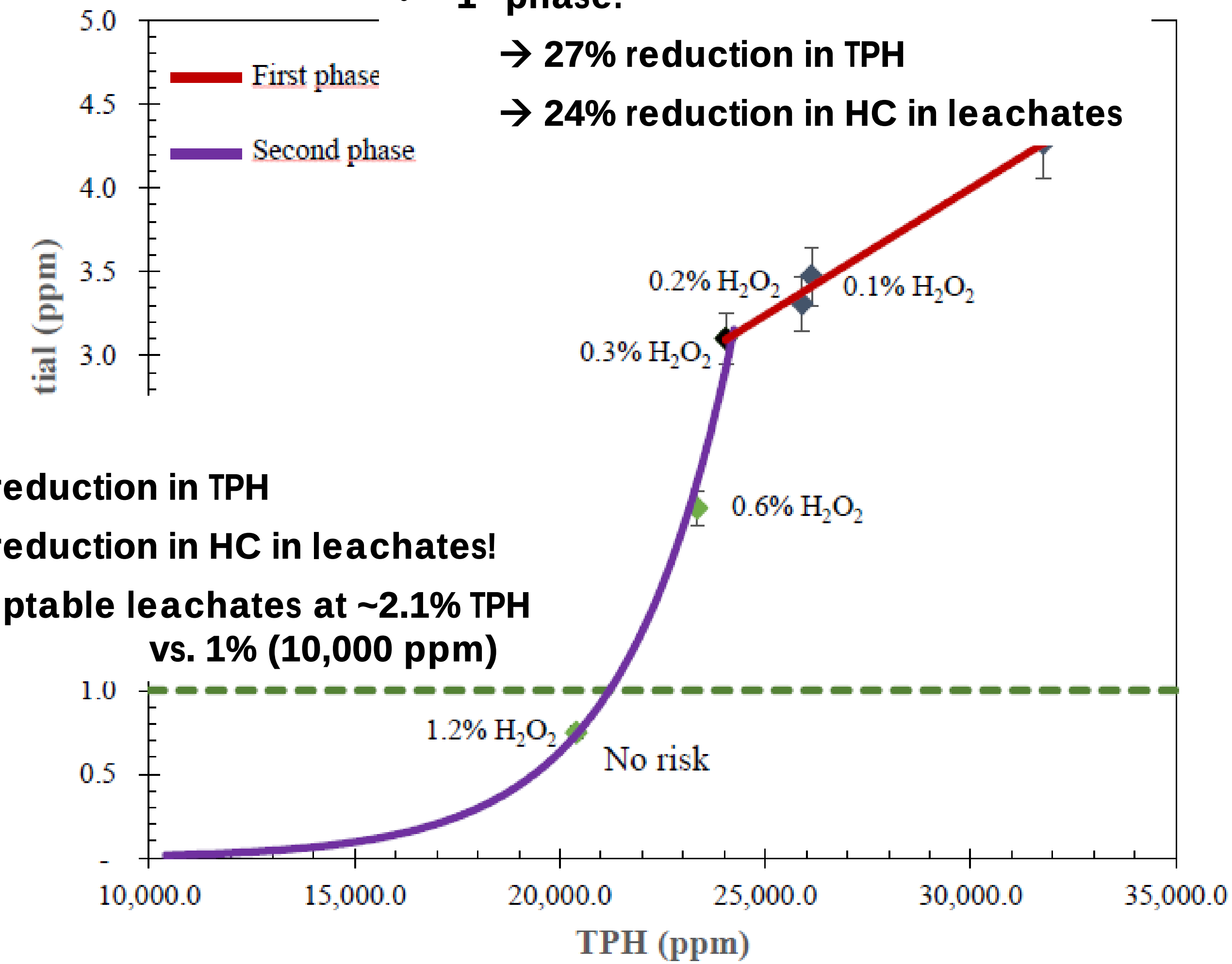
Hydrocarbon Concs. in Leachates



- **82% reduction in TPH in leachates!**
- **does not level off as much**

Comparison of Soil TPH and Leachates

- **1st phase:**
  - **→ 27% reduction in TPH**
  - **→ 24% reduction in HC in leachates**



- **2nd phase:**
  - **→ 15% reduction in TPH**
  - **→ 76% reduction in HC in leachates!**
  - **→ acceptable leachates at ~2.1% TPH vs. 1% (10,000 ppm)**

Conclusions

1) At only 1.0% w/w H_2O_2 a concentration of petroleum hydrocarbons in leachate safe for human consumption (< 1mg/l) could be obtained even with a final hydrocarbon concentration in soil >2%.

2) Alternative strategy focused on direct impacts (leachates) vs. TPH in soil allows for site remediation at higher TPH levels

→ much less cost

Conclusions

Optimization using:
1) lab/field test for reactant ratios

2) Specialized equipment designed for mixing (ALLU)

- **Actual on-site processing times approx. 2 – 4 weeks**
  → could have been reduced by about 1/2

- **Could have used about 1/3 – 1/5 less reagent**
  → save money, time

- **Actual TPH reduction of 65 – 85%**
  → could have been reduced to only 35%

Conclusions

Importance of really focusing on what is the problem

(rather than on some TPH number)

- **Probably longer but possible up to 70,000 ppm initial TPH**

- **Complications with higher concentrations, especially in asphaltenes contaminated soil**

→ formation of oily crust?

Thank you for your attention