

# Sustainable Remediation Practices

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the "business of brownfields"



# Presentation Overview

The ultimate goal of remediation systems is to protect human health and the **environment**. However, in order to meet goals, many remediation approaches today were implemented without consideration of **sustainable practices**, and in turn have not considered their potential for transferring impacts to other media.

Considering **sustainable factors** (during the remedy selection phase and as part of Brownfields redevelopment) will greatly improve the overall environmental performance of a remedy. **Sustainable remediation** maximizes the net environmental, societal, and economic benefits of a cleanup.

# Sustainable Practices

Historically... decision makers have not considered **sustainable remediation practices** primarily due to:

- Lack of information available on “**green**” technologies
- Few tools to evaluate/demonstrate effectiveness of “**green**” technologies

Today... decision makers recognize need to address.... environmental, economic & social aspects of sustainability... as part of the overall cleanup goals.

# Sustainable Remediation



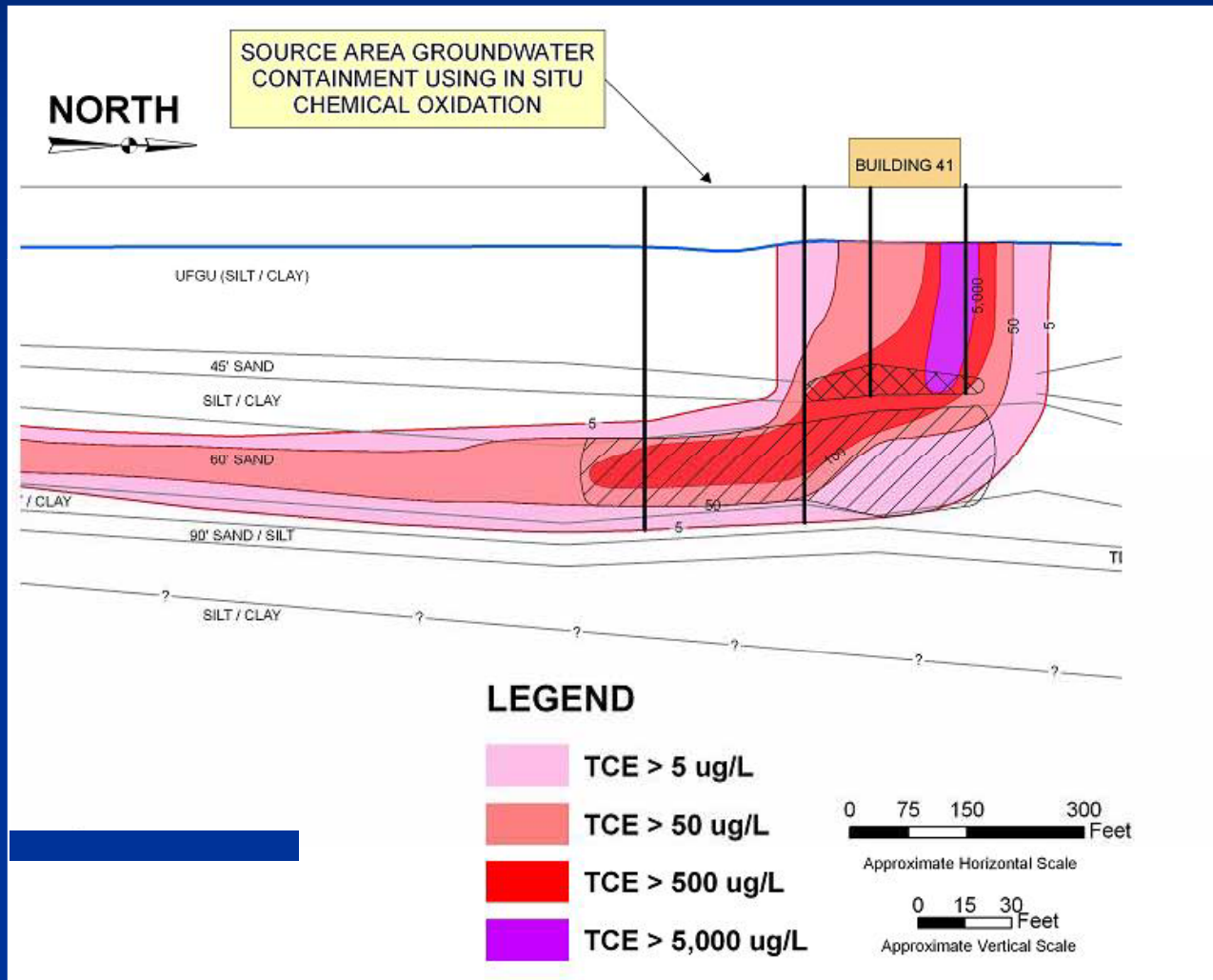
In-Situ Treatment of Chlorinated Solvents  
(adjacent to propane storage & beneath industrial buildings)

# What is Net Benefit?

Questions to consider in evaluating “net” environmental benefit & effects of cleanup action, include:

- What is the quantity of remediation process-related contamination?
- How is risk to human health & environment minimized by “sustainable” technology?
- Can energy (related to cleanup) be reduced... or can an alternative source of energy be used... which is less harmful to human health & environment?
- Why promote use & selection of “green” technologies?

# Hydrogeologic Profile



# Sustainable Remediation In-Situ Treatment

- Sodium Persulfate  $\text{Na}_2\text{S}_2\text{O}_8$  is an oxidant in its own right. Oxidation potential of  $E^0 = 2.1 \text{ v}$
- Each persulfate anion requires two electrons. For TCE:
- $$3\text{NaS}_2\text{O}_8 + \text{C}_2\text{HCl}_3 + 4\text{H}_2\text{O} \rightarrow 2\text{CO}_2 + 9\text{H}^+ + 3\text{Cl}^- + 3\text{Na}^+ + 6\text{SO}_4^{2-}$$
- The anion can be converted (activated) to 2 sulfate radicals or one radical and one sulfate anion. The sulfate radical requires one electron and promotes kinetically fast reactions. Oxidation Potential of  $E^0 = 2.6 \text{ v}$ 
$$\text{SO}_4^{\bullet-} + e^- \rightarrow \text{SO}_4^{2-}$$

# Sustainable Remediation

Sustainable remediation builds on already established environmentally practices, which are presently in use across business and public sectors:

- Increasing energy efficiency of remedial system (e.g., water & electric usage),
- Improving overall water quality,
- Managing & minimizing waste or byproducts, and
- Reducing emission of air pollutants & greenhouse gases

# Energy Usage on Cleanups

*Table 2. Technologies used for Superfund cleanups often involve energy intensive components such as ground water extraction pumps, air blowers, or ultraviolet lamps (U.S. EPA/OSWER, 2008(b)).*

Technology	Estimated Energy Annual Average (kWh*10 <sup>3</sup> )	Total Estimated Energy Use in 2008-2030 (kWh*10 <sup>3</sup> )
Pump & Treat	489,607	11,260,969
Thermal Desorption	92,919	2,137,126
Multi-Phase Extraction	18,679	429,625
Air Sparging	10,156	233,599
Soil Vapor Extraction	6,734	154,890
Technology Total	618,095	14,216,209

*Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*

- U.S. EPA Office of Solid Waste and Emergency Response  
April 2008

# Sustainable Ideas

Sustainable approaches are constantly being developed:

- Designing treatment systems with optimum efficiency or modifying existing systems
- Using “green” energy (e.g., solar power) to provide or supplement high-energy remedial equipment or treatment systems or equipment
- Beneficially using byproducts to generate electricity (e.g., methane gas from landfills)

# Combined “Green” Remediation Technologies

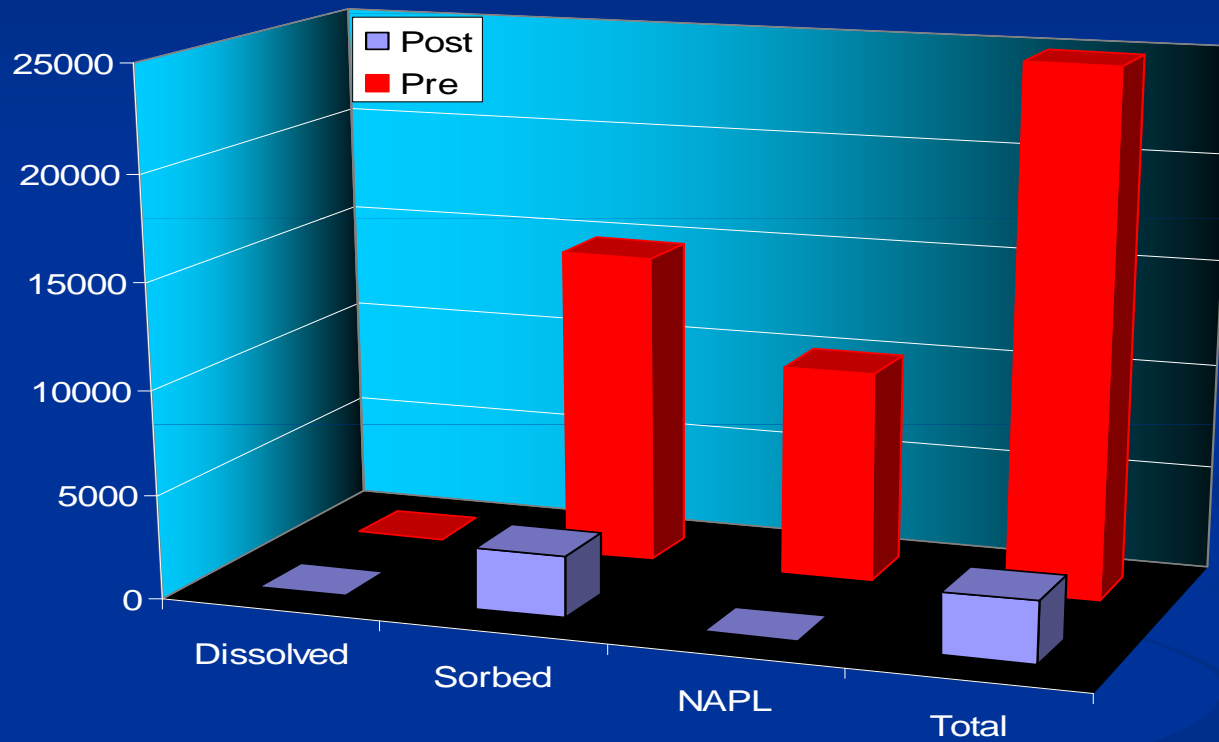
Method	Benefit
Bio-chem innovative process	Cost effective with enhanced treatment time
Steam activation of sodium persulfate	Desorption, high oxidation potential, and greater persistence
ISCO with pump and treat or air sparging/SVE	Rapid desorption, and increased efficiency

# Sustainable Remediation Bulk Fuel Terminal (Texas)



- 92 wells simultaneous
- Single 28-day application
- Effective ROI:
  - 16 ft in dissolved
  - 8 feet in NAPL
- No disruption to on-site business operations

# Mass Reduction Bulk Fuel Terminal (Texas)



Overall Mass Reduction: 88%

# Real-Time Monitoring



# Real-Time Field Data



**Real-Time Persulfate  
Monitoring**



**Real-Time Iron  
Monitoring**

# Exposure Pathways Ex-Situ Treatment (California)

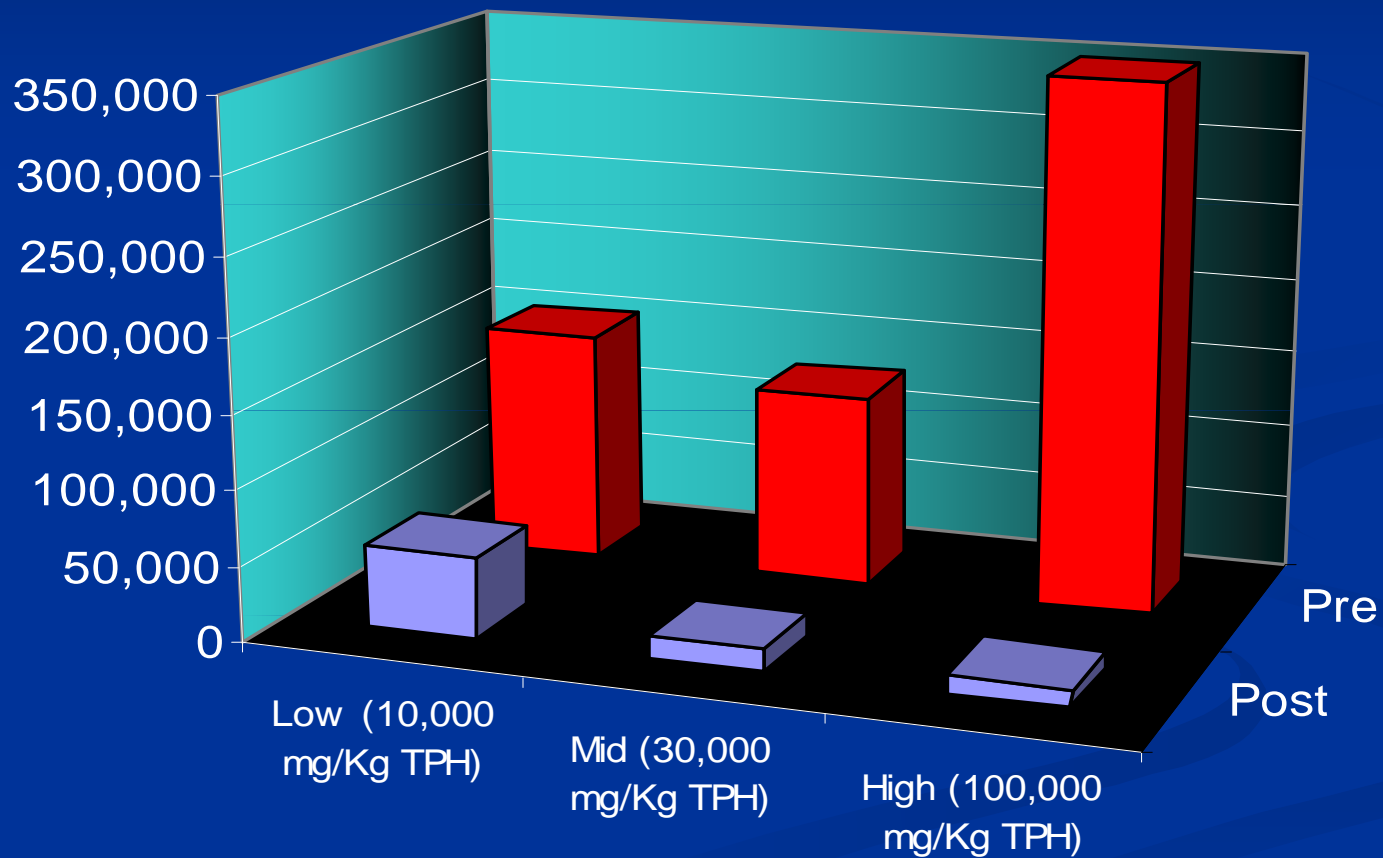


**Wide Area  
Broadcasting**

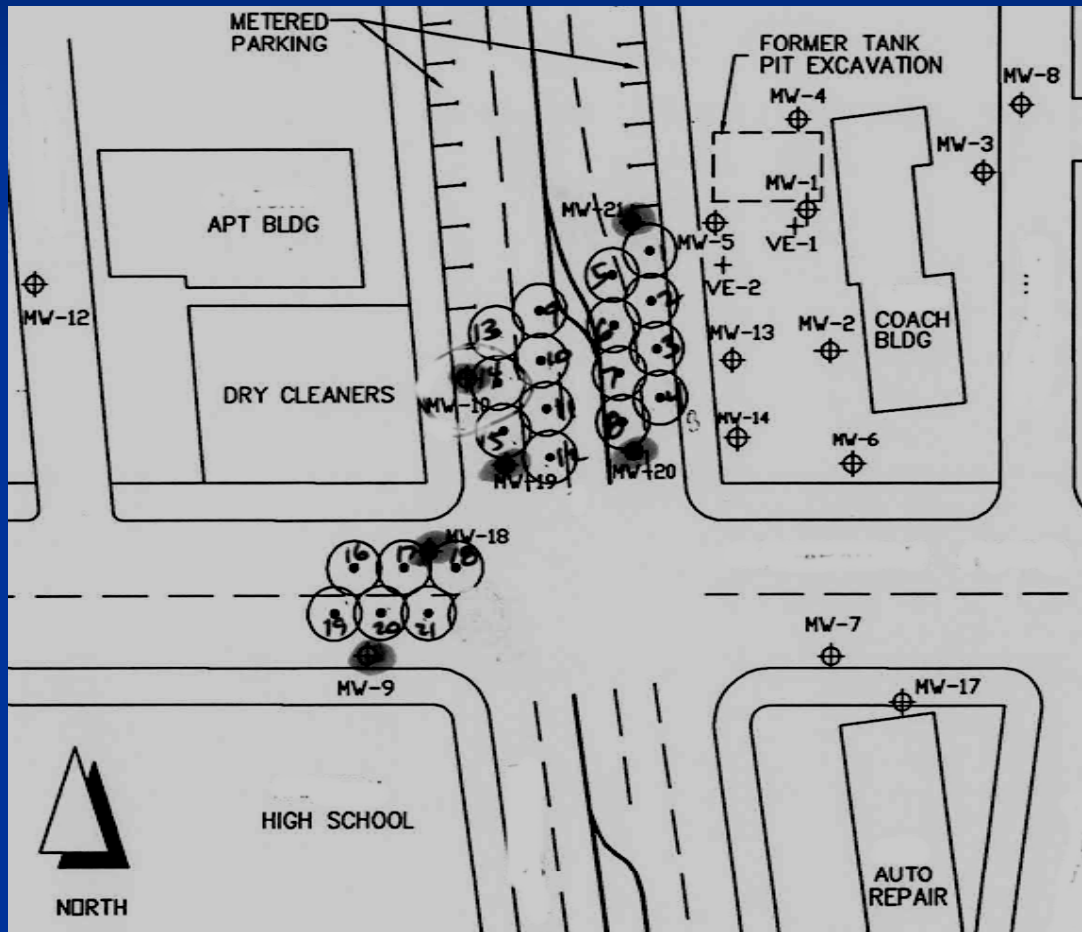


**Race-Way  
Application**

# Mass Reduction Ex-Situ Treatment (California)



# In-Situ Treatment Brownfields Redevelopment



Active Facilities  
(School, Retail,  
Auto Repair,  
Residential)

Sewers

Tight Soils

# Vapor Treatment

## Brownfields Redevelopment



# Resources

At present, there is significant interest in further understanding “green” and sustainable remediation practices.

Green Remediation, EPA’s Technology Innovation Program

<http://www.clu-in.org/greenremediation/index.cfm>

Air Force Center for Engineering and the Environment

<http://www.afcee.af.mil/resources>

Sustainable Remediation Forum (SuRF)

<http://www.sustainableremediation.org/>

- industry led group to enhance efforts to integrated sustainability principles, practices and metrics into remediation projects



# Think “Green”

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