Green Remediation Case Histories

Remediation Partners

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Remediation Partners

Remediation Partners
Vision Statement

- ✓Offer innovative site remediation technologies
- ✓Utilize sustainability principles when restoring contaminated properties
- ✓Provide additional value to our clients by maximizing their investment
- ✓Improve the quality of life of impacted community

GREEN vs. SUSTAINABLE REMEDIATION WHAT IS THE DIFFERENCE?

Green Remediation

- Practice of considering all environmental effects of remedy implementation & incorporating options to maximize environmental benefit of cleanup actions (USEPA)
- Current focus is on minimizing impacts post-remedy selection
- Primary focus of most regulatory initiatives

Sustainable Remediation

- Selection & implementation of remedy whose net benefit on human health & environment is maximized through judicious use of limited resources (SURF, 2009)
- Encourages evaluation of impacts of remedy during remedy selection process
- "Triple Bottom Line" – environmental, economic & social benefits
- Organizations such as ASTM, ITRC & SURF are tackling broader issue of sustainable remediation

Sustainable Remediation

- Improving traditional remediation through adoption of thoughtful remediation plan that incorporates following:
  - Actions that decrease environmental footprint
  - Cost-effective yet still protective approach
  - Minimal transfer of problem from one medium to another
  - Increase in community benefits
  - Consideration of safety associated with the action
  - Common sense
- These elements are consistent with USEPA policy & seek to take Green Remediation a step further

Tenets of Sustainable Remediation

- As environmental professionals we should implement remediation projects in a green (environmentally responsible) manner
- Green metrics probably have limited role on time-critical remediation projects (imminent risk) but can be applied
- Protection of human health & environment and compliance with ARARs are baseline requirements
- All relevant stakeholders should have a say in decision-making and by default the remedy selection
- Goals include reduced consumption of energy, water & other natural resources; maximization of reuse/recycling; and minimization of carbon footprint, GHGs & any other deleterious effect of remediation
- We can make better remediation decisions through accounting for metrics that were not previously considered

COMMON OBJECTIVES

- Achieve remedial action goals
- Support use/reuse of remediated parcels
- Increase operational efficiencies
- Reduce total pollutant and waste burdens
- Minimize degradation or enhance ecology
- Reduce air emissions & GHG production
- Conserve natural resources
- Evaluate recycling options & alternate treatment methods
- Minimize impacts to water quality & water cycles
- Increase sustainability of site cleanups

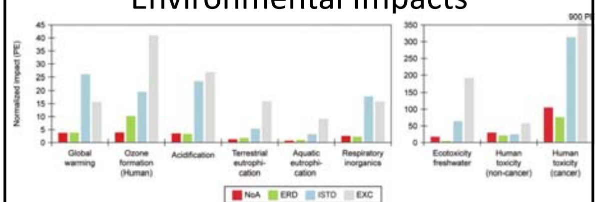
TOUGH QUESTIONS TO CONSIDER

- How do we weigh need for site restoration (cleanup soil, sediment and groundwater) against resources utilized & unintended consequences that result when attempting to accomplish that restoration?
- Should sustainability metrics be evaluated before or after remedy selection?
- Is it better to have short-term significant environmental footprint (excavation or thermal treatment) or extend it over a longer period (SVE or pump & treat)?

TOUGH QUESTIONS TO CONSIDER

- Does future carbon constrained world change the game?
- What is "reasonable timeframe"?
  – Should timeframe be tied to goal?
  – Who decides?
- How does one consider social impacts?
- How should health & safety and risk of remedy be considered?

Remediation Technology Environmental Impacts



Lemming, et al, Environmental Impacts of Remediation of a TCE-Contaminated Site: Life Cycle Assessment of Remediation Alternatives, 2010

EVO Carbon Footprint

- Emulsified Vegetable Oil (EVO) – widely used electron donor for anaerobic biodegradation of chlorinated solvents.
- Contents
  – Soybean oil
  – Food grade surfactants
  – Sodium lactate
  – Nutrient package
  – Water

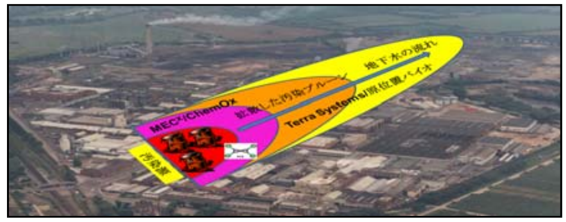
Carbon Footprinting Tool

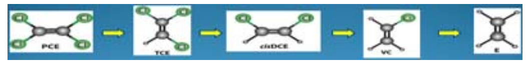
- Used Carbon Calculations over the Lifecycle of Industrial Activities (University of Manchester).
- Includes carbon footprint of all activities required to produce SRS® substrate
  – Planting, harvesting, transportation, & crushing activities required to make soybean oil
  – Energy consumption in all phases of the SRS® component production process.

Carbon Footprint Results

- Carbon footprint of 0.73 pounds of CO_{2e} per pound of SRS® substrate.
- Transportation from factory to job site will add approximately 0.000022 pound CO_{2e} per mile.

塩素系溶剤汚染？





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我々の浄化パートナーは、汚染問題を解決できる適切な浄化技術・解決策を提供できます。

Terra Systems INCORPORATED

Terra Systems

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脱塩作用微生物

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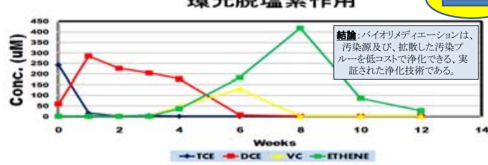
環元脱塩素作用



SABRE Project

InSitu Source Area BioREmediation

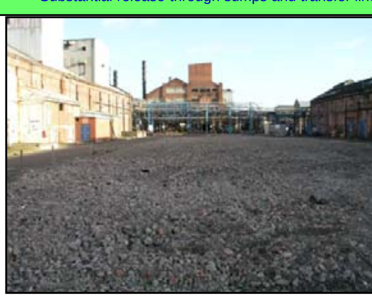
Public-private partnership for development of remediation technology

To evaluate the performance of enhanced anaerobic bioremediation for treatment of DNAPL source areas

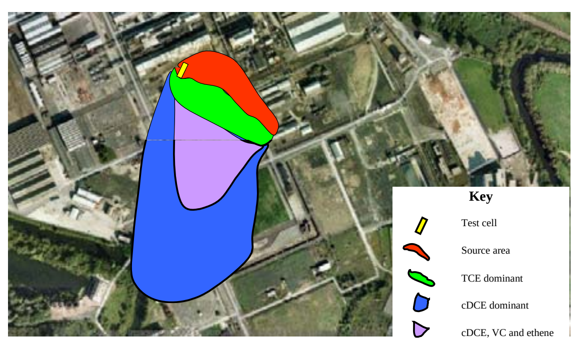
Companion *Streamtube* Project, provided substantial additional monitoring focused on quantifying chemical transport along flow paths from DNAPL source (University of Birmingham & British Geologic Survey)

SABRE Test Site

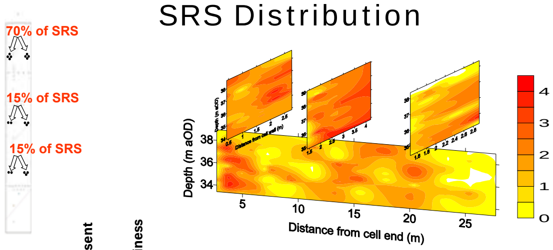
Former chemical manufacturing facility in England
- TCE used as a process chemical
- Substantial release through sumps and transfer lines

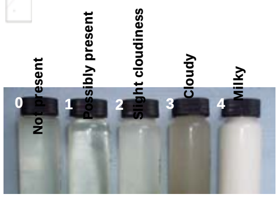


CONTAMINANT PLUME MAP



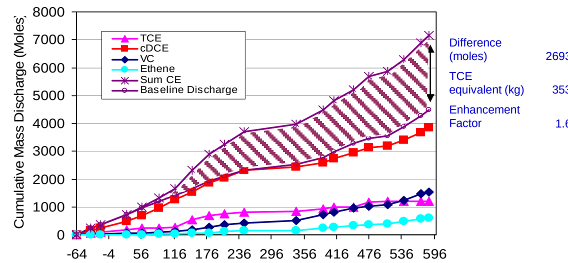
SRS Distribution





- SRS distributed over most of the cell
- "Patchy distribution", greater quantities at inlet

Flux Enhancement



Using initial increase in total ethenes from 4000 µM to > 8000 µm (slide #7) , enhancement factor of >2 is possible

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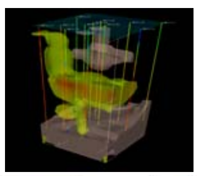
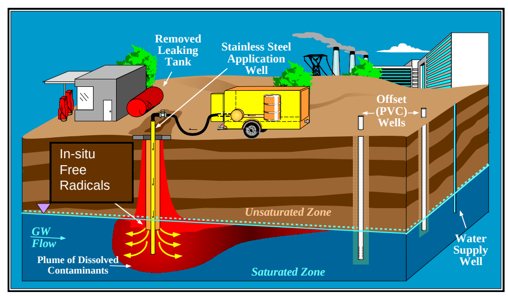


MEC^{X}-ISCO



Free Radical Chemistry

$H_2O_2 + Fe^{+2}$ (acid) → OH• + OH- + Fe^{+3}

OH• + Organic Contaminant → $CO_2 + H_2O$

Relative Power of Chemical Oxidants

Reactive Species	RelativeOxidizing Power
Hydroxyl Radical	2.06
Activated Persulfate	1.91
Ozone	1.52
Persulfate	1.48
Hydrogen Peroxide	1.31
Permanganate	1.24
Chlorine Dioxide	1.15
Chlorine	1.00

Activated Persulfate

$$S_2O_8^{2-} \xrightarrow{\text{activation}} 2SO_4^{-\bullet} + SO_4^{-\bullet} + e^-$$

$$+ \text{Contaminant} \longrightarrow SO_4^{2-} + CO_2 + H_2O$$

Persulfate Activation Methods

- Presence of transition metals
- Heat activation
- Hydrogen peroxide
- High pH activation

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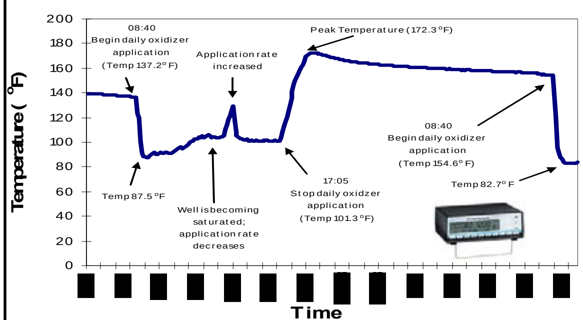
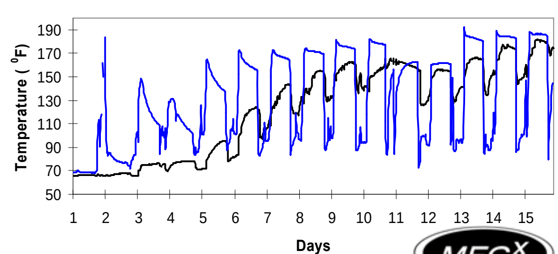
ISCO-Reagent Delivery

MEC^{X}-ISCO Temperature Monitoring

ISCO Temperature Trend



Temperature Trends During ISCO Process Application



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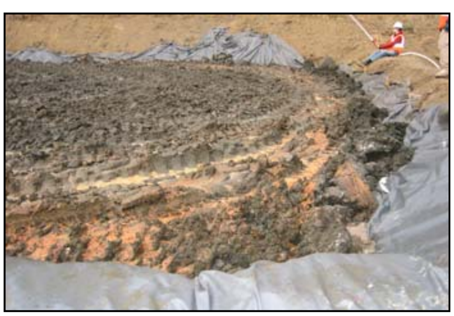
Remediation-Massachusetts

Viscous NAPL Removal

Ex-situ Remediation

Reagent Mixing Technologies

ESCO Hydration



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