human energy®

sustainable remediation practices

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Outline

- Sustainable remediation (SR) – a definition

- Project background and objectives
  - –Communicate the benefits of implementing SR practices

- What we did
  - –Review the types of SR practices

- Results
  - –Share lessons learned/best practices

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definition

- ITRC. 2011. “Technology Overview - Green and Sustainable Remediation: State of the Science and Practice.” Washington, D.C.: Interstate Technology & Regulatory Council, Green and Sustainable Remediation Team. May 2011

ITRC Sustainable Remediation definition –

– *A remedy or combination of remedies whose **net benefit to human health and the environment** is **maximized** through the judicious use of resources and the selection of remedies that consider how the **community, global society, and the environment** would benefit, or be adversely affected by, remedial investigation and corrective actions*

- The concept of sustainable remediation has been brought to the forefront by efforts from the **Sustainable Remediation Forum (SURF),** ASTM, Interstate Technology and Regulatory Council (ITRC) and US Environmental Protection Agency, among others, to **reduce the potential social, environmental and economic impacts associated with remediation while achieving the benefits of undertaking remediation**

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aspects

- **Sustainable Remediation Practices (SRPs)** are those practices in remediation project that provide a benefit in these aspects of sustainability -

1. **Energy use.** The energy use criterion focuses on the use of sources of renewable energy where available and appropriate, increasing energy efficiency, and reducing overall energy use, including electricity and fuel usage.

2. **Air emissions.** The air emissions criterion focuses on reducing or eliminating the generation of particulate, volatile or other air pollutants.

3. **Water conservation.** The water conservation criterion focuses on reducing water usage, reusing water and reducing water extraction.

4. **Waste reduction.** The waste reduction criterion focuses on reducing use of virgin materials, reusing/recycling materials and eliminating or reducing the generation of solid and liquid waste material during all aspects of remediation.

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aspects

- Sustainable Remediation Practices (SRPs) are those practices in remediation project that provide a benefit in these aspects of sustainability -

6. **Social benefits.** The social benefits criterion focuses on activities that involve or benefit the life of the community surrounding the site and support the implementation of SRPs. Examples include HSA plans, education and cultural interactions.

7. **Economic benefits.** The economic benefits criterion focuses on effects of implementation of a sustainable practice on the costs of achieving the remediation goals. Economic benefits consider the overall benefit of completion of the remediation on the future use of the site and the contribution of the use of the site on the economy of the surrounding area.

8. **Land and Ecosystems benefits**. The land and ecosystems benefits criterion focuses on reducing impacts on the land and the ecosystems and enhancing the ecological value of a specific area.

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what we did

- We developed a **simple framework** for identifying and evaluating aspects of SR and then we applied this framework to a set of projects at **different phases of remediation.**

- SR practices were **implemented at sites for a variety of reasons** including lowering environmental footprints and improving remediation efficiency, field worker safety, community relations, and overall cost-effectiveness of the project.

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example results

SUSTAINABLE REMEDIATION PRACTICES	II	III	IV
	ASSESSMENT	REMEDIATION	MONITORING
NO-PURGE SAMPLING USING HYDRA-SLEEVE SAMPLERS	X	X	X
LOW-FLOW PURGING/SAMPLING	X	X	X
SULFATE APPLICATION TO ENHANCE BIODEGRADATION			
SULFATE SURFACE APPLICATION USING PULVERIZED GYPSUM AND SURFACE IRRIGATION		X	
SULFATE APPLICATION USING PERMEABLE FILLED BORINGS (PFB) AND HIGH PRESSURE INJECTION BORINGS (HPI)		X	
SULFATE APPLICATION USING VERTICAL CONDUITS WITH INITIAL SURFACE IRRIGATION		X	
CATALYTIC OXIDATION TO REDUCE OPERATING TEMPERATURES AND ENERGY USE		X	
CYCLING GROUNDWATER TREATMENT SYSTEM		X	
VARIABLE FREQUENCY DRIVE HIGH OUTPUT ELECTRIC MOTORS TO CONTROL FLOW RATES AND REDUCE ENERGY USE.		X	
RECOVERED LNAPL AS A FUEL SOURCE		X	
RECYCLED AND REUSE OF MATERIALS (E.G., SHEET PILING, CONCRETE) GENERATED DURING DEMOLITION ACTIVITIES ON SITE.		X	

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example results

SUSTAINABLE REMEDIATION PRACTICES	II	III	IV
	ASSESSMENT	REMEDIATION	MONITORING
INCORPORATING ECOLOGICAL CONSIDERATIONS INTO REMEDIAL ACTION IMPLEMENTATION USING:			
TEMPORARY (VERNAL) POND SYSTEM TO REDUCE THE AMOUNT OF BACKFILL SOILS AND CREATE HABITATS		X	
NATIVE VEGETATIVE COVER FOR LAND TREATMENT UNIT.		X	
SHORT GRASS PRAIRIE ECOSYSTEMS TO PROVIDE HABITAT TO MONARCH BUTTERFLIES, POLLINATORS, BIRDS AND MAMMALS.		X	
IN SITU BIO-BARRIERS FOR BIOLOGICAL AND GEOCHEMICAL DEGRADATION		X	
PHYTOREMEDIATION IN CONJUNCTION WITH MONITORED NATURAL ATTENUATION		X	
VADOSE ZONE RIPPING FOR CO_2 TO ENHANCE NATURAL ATTENUATION IN SOIL		X	
PASSIVE (WIND -DRIVEN) AIR SPARGING		X	
INCORPORATE BROKEN-UP CONCRETE AND SELECTIVE EXCAVATION TO MEET OBJECTIVES FOR RESTORATION TO A NATURAL AREA		X	
INTERMITTENT LNAPL RECOVERY SYSTEM TO ADDRESS LNAPL SOURCE ZONES		X	
MONITORED NATURAL ATTENUATION		X	
COMMUNITY ENGAGEMENT	X	X	X
RESEARCH PROJECTS	X	X	X

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Phytoremediation

- Phytoremediation uses trees or other plants to **remove or stabilize** chemicals of concern from **groundwater and/or soil**.
- The uptake of water by the plants may also create **hydraulic control**.
- The **degradation process** includes microbial degradation, chemical stabilization, and phytovolatilization of chemicals of concern.
- Phytoremediation has **low energy requirements** as it does not require intrusive methods for implementation.
- Aesthetic value.

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Situ Sulfate Application

- In Situ Sulfate Application (ISSA) is used to **enhance bioremediation** of **dissolved** petroleum hydrocarbons in groundwater.

- The sulfate application as a **surface application of gypsum** with irrigation allows the sulfate-rich water to infiltrate groundwater; or by using **borings that are filled with gypsum** and gravel which are injected with a gypsum slurry

- ISSA has low energy requirements and generally lower level of disturbance as it does not require intrusive methods for sulfate delivery.

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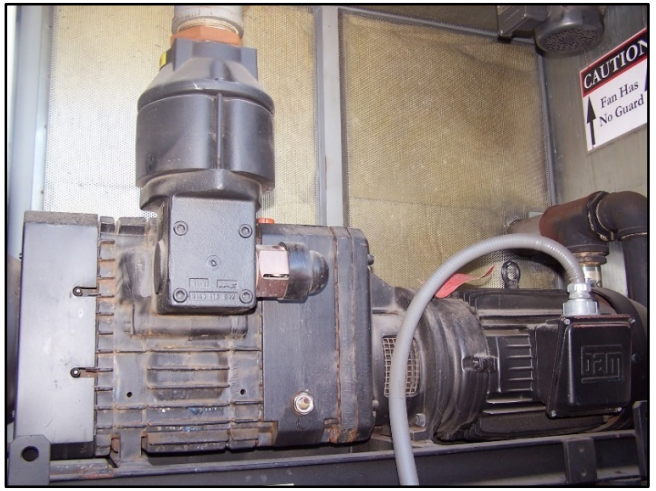
Recycling and reuse

- Recycling and reuse of equipment and material generated during remediation or demolition of a site (e.g., concrete, rebar) reduces the amount of waste materials generated at a site. It also reduces the amount of new materials and new equipment that is needed.
- **Third party** waste disposal services offer the option of **waste recycling** at many locations.
- **Remediation system inventory** provides a list of available remediation equipment for re-use.



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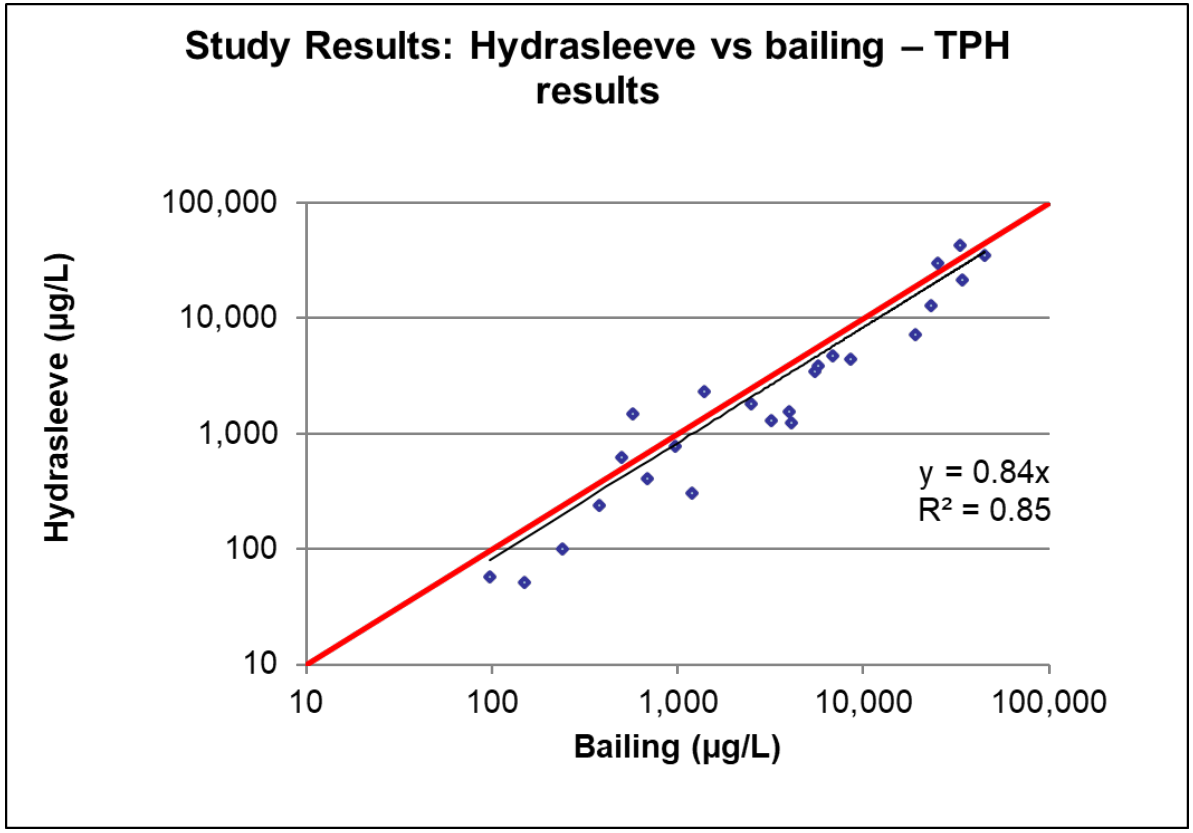
No-purge sampling for groundwater monitoring

- Passive sampling.
- Collect a sample of groundwater from the monitoring well with **minimum disturbance** and **without generating purge water** for disposal.
- Advantage of generating **smaller or no volumes of water** for disposal and **minimizing** the amount of **technician's time on site**.



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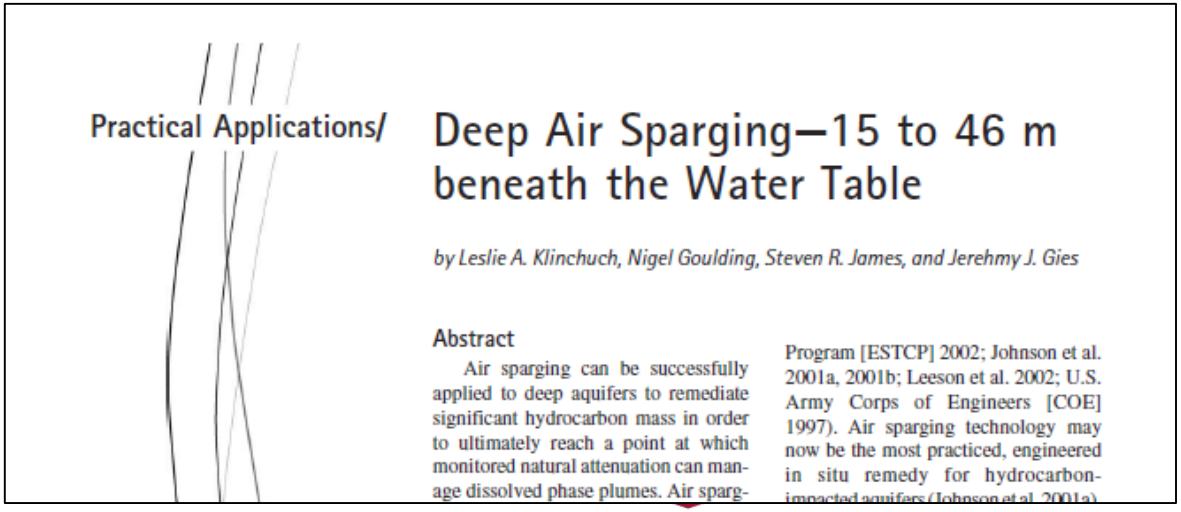
University collaborations

- Research advancements captures a wide range of cooperative projects at sites with universities and industry groups.

- The use of **real-world field sites** to investigate new technologies, or implement basic research. The projects themselves benefit the specific cleanup project by providing knowledge, measurements and insights that would not be gained through the standard cleanup activities.

- There is a benefit to the scientific community in **furthering the knowledge** of cleanup sites in **complex field environments** that are not easily replicated in the laboratory.



Practical Applications/

Deep Air Sparging—15 to 46 m beneath the Water Table

by Leslie A. Klinchuch, Nigel Goulding, Steven R. James, and Jerehmy J. Gies

Abstract

Air sparging can be successfully applied to deep aquifers to remediate significant hydrocarbon mass in order to ultimately reach a point at which monitored natural attenuation can manage dissolved phase plumes. Air sparg-

Program [ESTCP] 2002; Johnson et al. 2001a, 2001b; Leeson et al. 2002; U.S. Army Corps of Engineers [COE] 1997). Air sparging technology may now be the most practiced, engineered in situ remedy for hydrocarbon-impacted aquifers (Johnson et al. 2001a).

Publication of Chevron-funded remediation research work http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6592.2007.00150.x/abstract

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results

- SRPs are being implemented at remediation sites in a **safe and timely manner** that **increases the overall environmental, social and economic benefits of remediation**.

- SRPs are adopted as projects teams implement new measures to **increase field work safety, optimizing the work and reducing costs**.

- SRPs as alternatives tend to be the **preferred choice for project teams** because they can meet **cost and safety goals** while allowing the project teams to continue considering potential **human health and/or ecological risk.**

- Inconsistent application - SRPs are adopted ad hoc as project teams implement new measures and its implementation is not consistent across projects. Because of that, there are **missed opportunities** as some projects do not consider SRPs while others do.

- Communication opportunities – SRPs are not necessarily well understood.

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Key outcomes

- Results demonstrated that sustainable remediation can be implemented across a **wide variety of remediation phases** as well as sites of **different sizes and risk profiles**.
- We learned that sustainability practices and **benefits may be hidden** or overlooked and that developing a sustainability framework is key to facilitating identification of sustainable remediation practices.
- Testing and documenting these innovative technologies provide benefits to the individual site as well as to the wider remediation community by advancing our understanding of effective sustainable remediation practices.

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Thank you!

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