Green Remediation:
Reducing the environmental footprint of contaminated site cleanups

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Carlos Pachon
pachon.carlos@epa.gov

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Office of Superfund Remediation and Technology Innovation

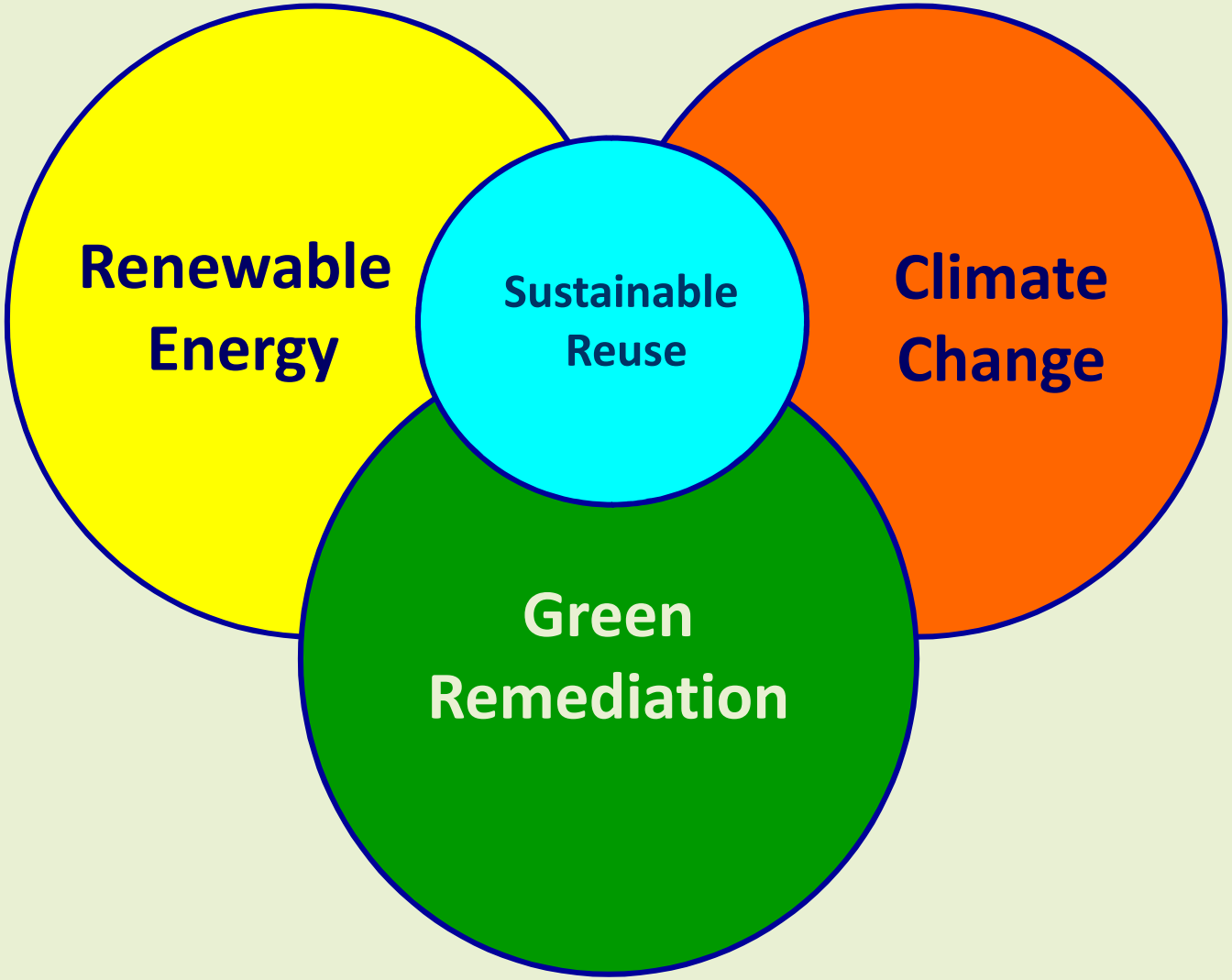
What is “Green Remediation”?

Definition: The practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup actions.

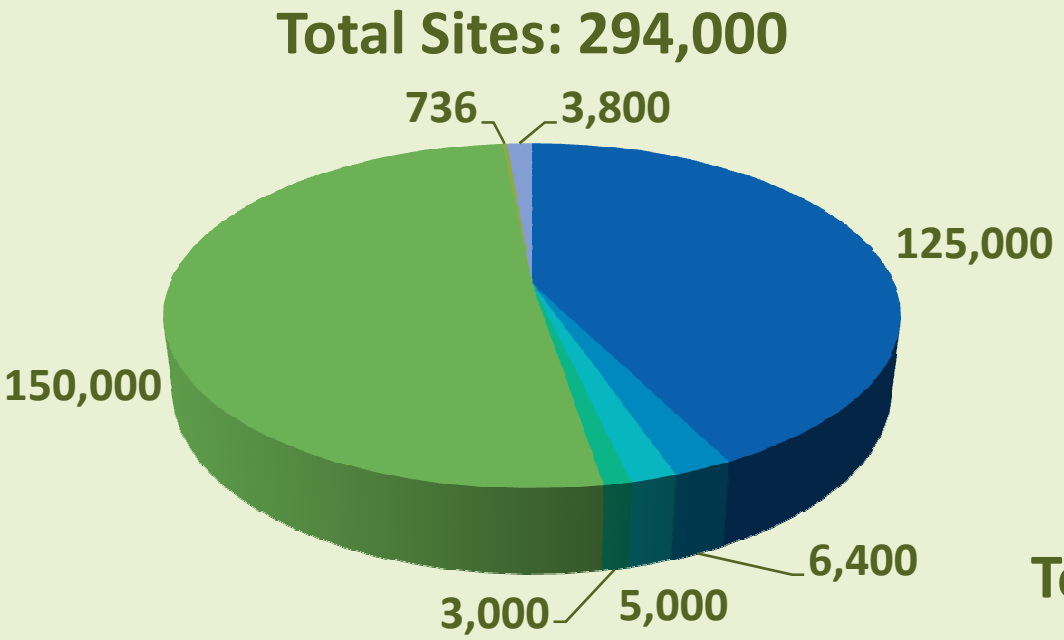
U.S. EPA Administrator's Comments on Stewardship & Sustainability

- "Enhancing EPA's ***environmental stewardship*** in the implementation of its core missions"
- "Harnessing non-regulatory agenda to enhance ***sustainability*** given limited resources"
- "How do actions taken on a ***regulatory basis*** help us advance sustainability?"
- "Think of ***simple*** things that have a broad impact"
- "Consider how the Agency impacts ***local communities*** in fulfilling it's mission"

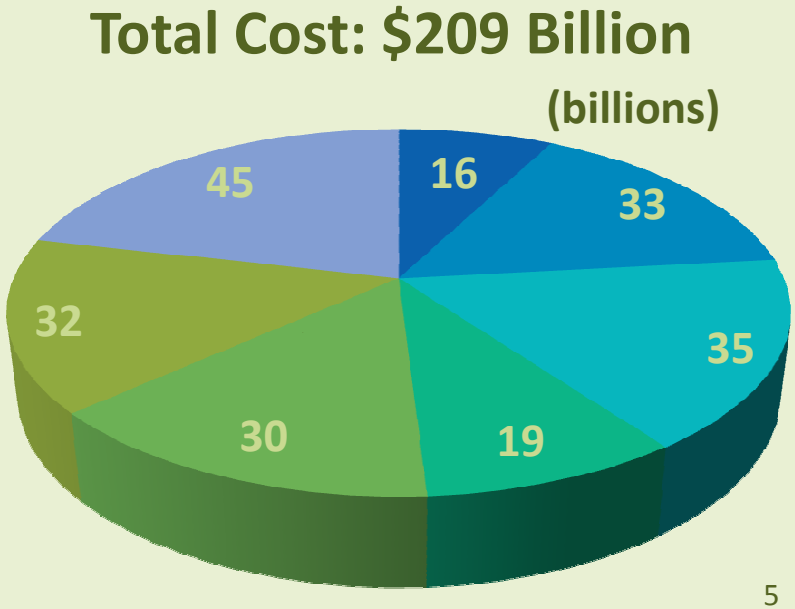
Related But Not Synonymous



There's Still Much Work to Do



- USTs
- U.S. DOD
- U.S. DOE
- Civilian Agencies
- State & Private
- Superfund NPL
- RCRA Corrective Actions



Source: http://cluin.org/market/

Green Remediation: Common Themes in Site Cleanup Programs

- Fits within existing frameworks
- Opportunities exist throughout site investigation, design, construction, operation, and monitoring
- Addresses core elements (see figure)

Core Elements: Air Emissions

- Lower air emissions leading to reductions in harmful particulate matter and ground-level ozone precursors
- Use of cleaner fuel and retrofit diesel engines
- Modified operations to reduce operating and idle time

Field Machinery and Vehicles Used for a Typical Multi-Phase Extraction Project over Five Years	Fuel (gallons)	CO_2 (lbs)
Site preparation: One Bobcat with intermittent use of flatbed trailer-truck or dump truck operating for 26 weeks	8,996	199,711
Well construction: Truck-mounted auger system installing ten 75-foot extraction wells over 30 days	612	13,586
Routine field work: Two pickup trucks for site preparation, construction, treatment system monitoring, sampling, and repair over five-year duration	19,760	383,344
Total for Project Life:	**29,368**	**596,641**

Construction could account for 30-40% of fuel consumption and air emissions of a cleanup.

Diesel oxidation catalysts, diesel particulate filters, selective catalytic reduction, and ultra-low sulfur diesel are options for reducing emissions from onsite equipment

Core Elements:
Water Requirements & Resources

- Minimum fresh water use and maximum reuse
- Prevention of water quality impacts, e.g. nutrient-loading or disruption of natural hydraulics
- Reclaimed treated or stormwater for beneficial use or storage
- Alignment with proposed EPA rule on construction effluent:
  - Specific BMPs at all construction sites
  - Sediment basins at sites > 10 acres
  - Numeric limits of turbidity at sites > 30 acres with high rainfall and clay content

Portable closed-loop wheel washing systems for reducing onsite and offsite trackout during construction

Rock-filled stormwater channels and erosion control blankets used for excavation and backfilling at former U.S. Navy landfill

http://cicacenter.org/cs.cfm

Core Elements: Land & Ecosystems

- Minimal habitat disturbance such as noise and lighting
- Soil and sediment protection from compaction, decon, or uncontrolled traffic
- Use of local byproducts such as fly ash or ag waste
- Ecosystem restoration and protection practices such as selecting native plant species and relocating affected animals

Metal salt crust along Upper Arkansas River in Colorado prior to Superfund removal

Ten years after applying municipal biosolids and assorted nutrients along the Arkansas River

"I promise I'll walk and feed him"

… alligator rescues during removal actions at contaminated swampland in Georgia

Core Elements:
Material Consumption & Waste Generation

- Site cleanups often require demolition work, use raw materials and generate waste
- Reuse and recycling of materials, including C&D debris and clean metal
- Reduction of secondary wastes such as soil corings, wastewater, expended chemicals, routine supplies, and single-use materials
- Passive sampling devices producing minimal waste
- Minimized extraction and disposal of natural resources

10,000^3-yd soil removal in Georgia yielding 280 tons of scrap steel and 58 tons of tin left by past wood treating

Concrete salvaging during cleanup at Barksdale AFB in Louisiana to help meet federal "greening the government" goals

Triad planning for 10-day mobilization to investigate plus conduct removal at Paducah GDP in Kentucky, and only 23 lab samples

Core Elements: Energy Requirements

- Renewable energy systems in remote locations or to offset grid electricity
- Optimized and effective treatment systems
- Energy efficient equipment operating at peak performance

PV array to pump 2-3 gpm of water through a low-energy mulch bioreactor at Altus AFB in Texas

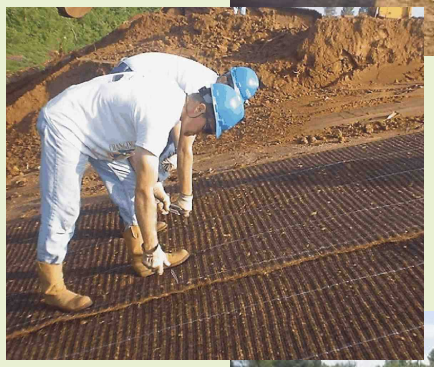
10-kW turbine for ground water circulation, reducing grid electricity consumption by 26% at former Nebraska ordnance plant

Portable PV system for 5-month SVE after oil pipeline break at Rocky Mountain House air base in Alberta, Canada

Profile of Implementing E.O. 13423

Barksdale Air Force Base, LA

- Low impact development strategies, e.g. recreating natural hydraulic patterns of wetlands
- 1,000 tons of concrete reused for stormwater runoff controls and road fill
- 700 tons of removed woody material reused in onsite conservation area
- 25-acre capped area re-vegetated with native flora



October 5th E.O. further builds on E.O. 13423

Profile of Renewable Energy for Cleanup:
Aerojet-General Corporation, Rancho Cordova, CA

- 3.5-MW solar farm powering nine plants
  - 100 wells extracting 20 mil gallons of water per day
  - Ex situ air stripping, UV/OX, and ion exchange
- 18,000 200-watt silicon-celled PV panels covering 20 acres
- 12 single-axis trackers supported by posts rather than concrete footing
- 20% of P&T system demand met through PV energy, avoiding 4,200 tons of CO_2, 16.7 tons of SO_2, and 6.5 tons NOx each year
- $15 mil in utility incentives and $10 mil in electricity savings over 25-year project life

OSWER Green Remediation "Strategy"

Major efforts in U.S. EPA/OSWER to advance green remediation best practices across cleanup programs:

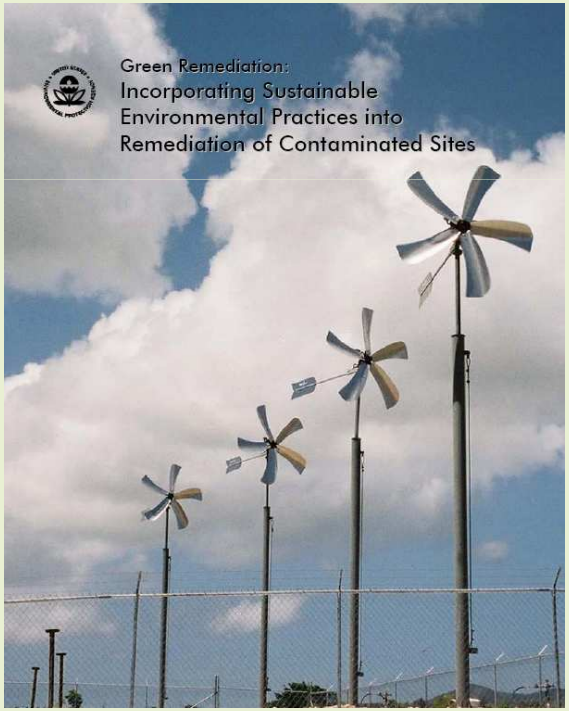
- **Principles for Greener Cleanups**: Common policy position for all U.S. EPA cleanup programs
- **Superfund Green Remediation Strategy**: "Operationalizing" the Principles in the Superfund Cleanup Program
- **Voluntary Green Cleanup Standards & Certification System**: A robust tool for fostering greener cleanups in the various cleanup programs
- **RE-Powering America's Land**: Renewable energy on contaminated lands

Key Action	Description
Policy and Guidance Development	
Key Action #1	Clarify the role of green remediation in remedy selection and implementation
Resource Development and Program Implementation	
Key Action #2	Develop a compendium of protocols and tools to help project and Program managers integrate green remediation practices
Key Action #3	Identify options that enable use of green remediation practices
Key Action #4	Address air pollutants and diesel emissions
Key Action #5	Develop pilot projects to evaluate and demonstrate green remediation applications
Key Action #6	Establish opportunities in contracts and assistance agreements to identify green remediation practices in selected remedies
Key Action #7	Communicate and share success stories and lessons learned among "implementers" across the Program and the public
Program Evaluation	
Key Action #8	Evaluate green remediation application at the site level
Key Action #9	Develop Program evaluation measures
Key Action #10	Evaluate the Superfund Green Remediation Strategy

More Information from U.S. EPA

CLU-IN Green Remediation Focus

www.clu-in.org/greenremediation



Aerojet-General Corporation	CA		☀	☁			
Altus Air Force Base	OK		☀	☁	💧		♻
Apache Powder	AZ		☀	☁	💧		
Barksdale AF Base	LA				💧	🌲	♻
BP Casper	WY					🌲	♻
BP Paulsboro	NJ		☀	☁			
California Gulch	CO			☁			♻
Crozet Orchard	VA		☀	☁	💧		
De Sale Restoration Area	PA		☀	☁	💧	🌲	♻
Delfasco Forge	TX		☀	☁			♻
Former Carswell Air Force Base	TX		☀	☁			♻
Former Ferdula Landfill	NY		☀	☁			
Former Nebraska Ordnance Plant	NE		☀	☁			
Former St. Croix Alumina Plant	VI		☀	☁			♻
Fort Carson	CO		☀	☁	💧		♻
Frontier Fertilizer Superfund Site	CA		☀	☁			