Environmental Footprint Analyses for Contaminated Site Cleanups

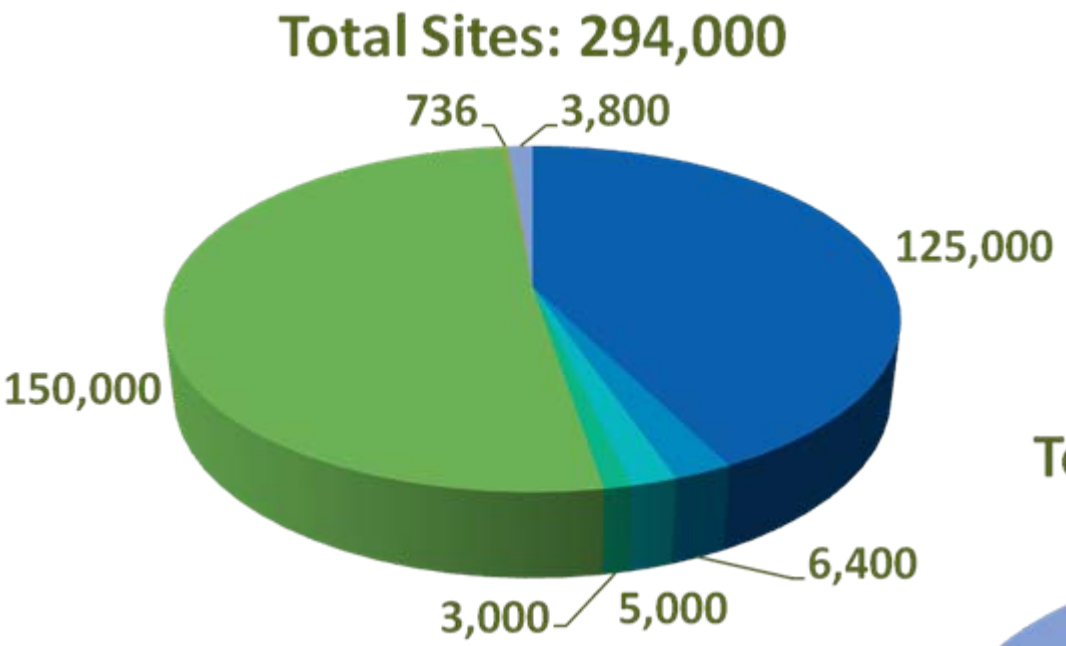
Green Remediation: Environment, Energy, Economics

UMass, Amherst, MA

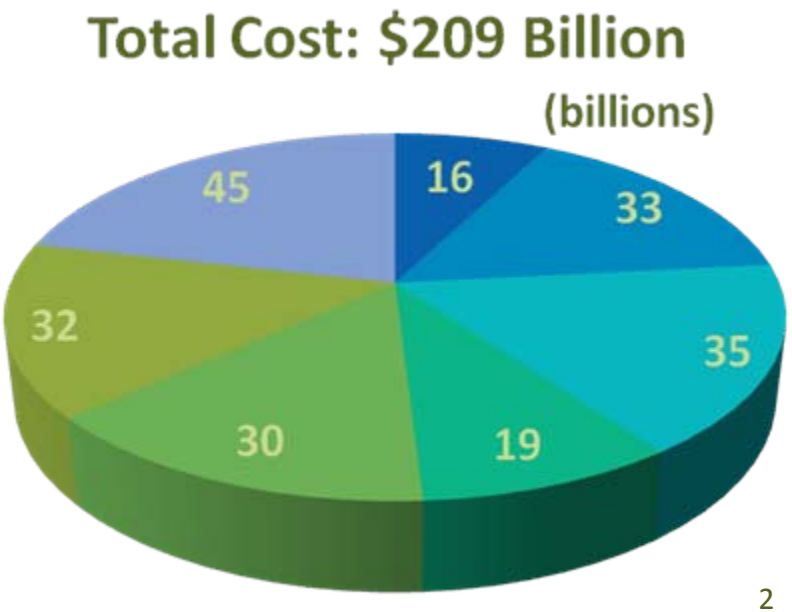
June 16, 2010

Carlos Pachon, U.S. EPA/Office of Superfund and Remediation Technology Innovation
Pachon.carlos@epa.gov

Remediation: 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/

2

Carbon & Energy Footprints of Superfund Cleanup Technologies

Technology	Estimated Energy *Annual Average* (kWh*10^3)	Total Estimated Energy Use *in 2008-2030* (kWh*10^3)
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*

	Annual Carbon Footprint (MT CO2)
Sum of 5 Technologies	404,411

Every Site Counts

Diesel Consumption in an Illustrative Excavation and Soil Amendment Project	Diesel Consumption (gallons)	PM Emission (pounds)[a]	NOx Emission (pounds)[a]	CO_2 Emissn (tons)[a]
Removing contaminated soil through use of an earth mover with a 1990 200-hp engine operating for 100 days	6,400	100	1,100	70
Hauling 35,000 yard^3 of excavated soil to an offsite waste disposal facility 300 miles away, by way of 60-yard^3, 425-hp tractor trailers[b]	77,000	770	10,970	850
Importing wood milling and agricultural waste from sources 50 miles away, by way of a 60-yard^3, 300-hp truck[b]	2,400	100	1400	30
Applying 2,000 tons of soil amendments over 20 acres, using a 1990 290-hp, 60-yard^3 dump truck and 1990 170-hp grader	260	8	1	3
Using two medium-duty pickup trucks for site preparation and remedy construction over six months[b]	380	7	170	4
Total diesel consumption and air emissions	**86,440 gallons**	**985 pounds**	**13,641 pounds**	**957 tons**

[a] Diesel Emissions Quantifier; http://cfpub.epa.gov/quantifier/view/welcome.cfm

[b] including use of ULSD, as required for on-road applications

Adding retrofitting devices such as a NOx catalyst and a diesel particulate filter could reduce these emissions by as much as 25% for NOx and 90% for PM.

4

EPA Footpring Evaluation Methodology : Goals

- Clearly outline EPA's expectations for environmental footprinting studies or green remediation evaluations
  - Provide a methodology for those preparing such studies
  - Provide guidance for EPA staff reviewing such studies
- Provide a common set of parameters to be used in conducting these studies
- Encourage the use of the Methadology
  - To help identify means of reducing a remedy's footprint
  - Reducing a remedy's footprint may result in an overall improved remedy

EF Methodology Effort: Goals (continued)

- Use methodology to encourage
  - Energy efficiency and use of renewable energy (on-site or through purchase of renewable energy certificates)
  - Use of materials and services manufactured/provided using sustainable practices and with a low environmental footprint
  - Water conservation and beneficial reuse of water
  - Remediation and redevelopment of contaminated property and preservation of currently undisturbed property
  - Preservation of existing ecosystems
  - Recycling and materials reuse

Footprint Analysis Metrics: Energy and Emissions

- Follow general structure provided by the World Resources Institute for greenhouse gas inventories
  - Minor changes in definitions that provide clarity for applying to remedies
  - Used by EPA Climate Leaders Program and other major greenhouse gas inventory programs
  - Distinguish between direct and indirect energy usage
- Distinguish between energy from conventional resources and energy from renewable resources
- Track emissions of GHGs, NOx, SOx, PM, and hazardous air pollutants

Footprint Analysis Metrics: Energy and Emissions

- Scope 1 – On-site energy use and emissions
  - Renewable electricity and energy
  - Conventional electricity and energy
  - Percentages of electricity and energy from renewable resources
- Scope 2 – Energy for generating grid electricity and emissions
  - Distinguish between renewable and conventional energy resources
- Scope 3
  - Transportation – Energy for transportation and emissions
    - Distinguishes between renewable and conventional energy
  - Other – Energy and emissions for other off-site activities
    - materials manufacturing
    - lab analysis, waste disposal, off-site water treatment
    - electricity transmission losses

Footprint Analysis Metrics: Water

- Water footprint analysis is complicated
  - Typically a local or regional resource
  - May be used in several locations in association with cleanup activities
  - Various types of water with varying water quality may be used in association with cleanup activities
  - Water may be returned to the environment in the same, improved, or reduced quality as a result of cleanup activities.
    - Goals
      - Provide useful information for potentially reducing footprint
      - Provide stakeholders with informative picture of water use

Footprint Analysis Metrics: Water

- Type of water used on-site
  - Potable water
  - Groundwater
  - Surface water
  - Reclaimed water
  - Collected or diverted storm water

  } Note water quality or extraction source

- Fate of water used on-site
  - Reinjection
  - Discharge to surface water
  - Beneficial use
  - Discharge to atmosphere

  } Note change in water quality

- Off-site or indirect uses of water
  - Materials manufacturing
  - Electricity generation
  - Off-site services

What is Needed?

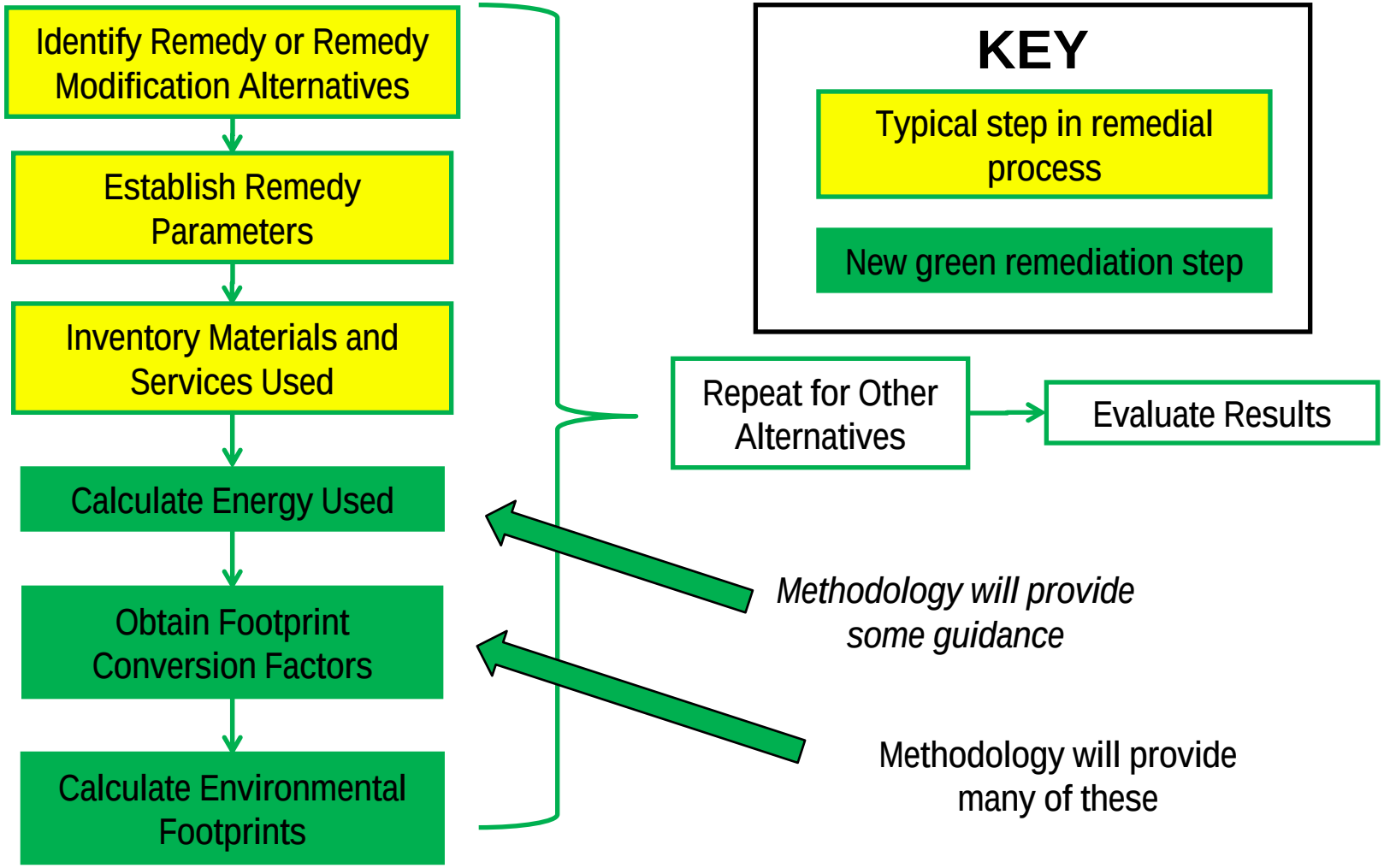
- On-site equipment use and fuel source
  - Electrical and natural gas equipment
  - Diesel and gasoline equipment
  - Other on-site sources or sinks of emissions

OR

Direct information about energy use and emissions

- Generation mix of electricity
  - eGRID
  - Local power company
- Materials use
  - Consider materials that cost more than X% of total remedy cost
- Off-site services (that cost more than X% of total remedy cost)
  - Laboratory analysis
  - Waste disposal and off-site water treatment

What are the Steps?



What about…?

- Renewable Energy Certificates (RECs) and purchased renewable electricity
  - Methodology allows purchased renewable energy or RECs bundled with grid electricity to be considered renewable energy*
  - Methodology allows for emissions offsets associated with purchased renewable energy and RECs*
- Carbon and other emissions
  - Methodology accounts for emissions reductions associated with purchased emission offsets or credits*

**** Some caveats apply***

Expected Output: Energy

Category	Electricity from Renewable Resources	Electricity from Conv. Resources	Total Electricity	Energy from Renewable Resources	Energy from Conv. Resources	Total Energy
	MWh	MWh	MWh	Mbtus	Mbtus	Mbtus
Scope 1	2.9	8.8	11.7	9,900	460,900	470,800
Scope 2				2,500	42,400	44,900
Scope 3 for Transportation				0	829,600	829,600
Scope 3 for Other Activities				0	3,217,018	3,200,000
Remedy Totals				12,400	4,500,000	4,512,000
% of Total Electricity from Renewable Resources	25%					
% of Total Energy from Renewable Resources	0.3%					

Expected Output: Emissions

Category	GWP lbs CO2e	NOx lbs	SOX lbs	PM lbs	HAPs lbs
Scope 1	69,600	519	17	10	0.93
Scope 2	9,900	16	28	0.56	1.2
Scope 3 for Transportation	132,800	876	31	12	2
Scope 3 for Other Activities	1,996,000	14,000	16141	893	124
Remedy Totals	2,209,000	15,400	16,217	916	127

Expected Output: Water

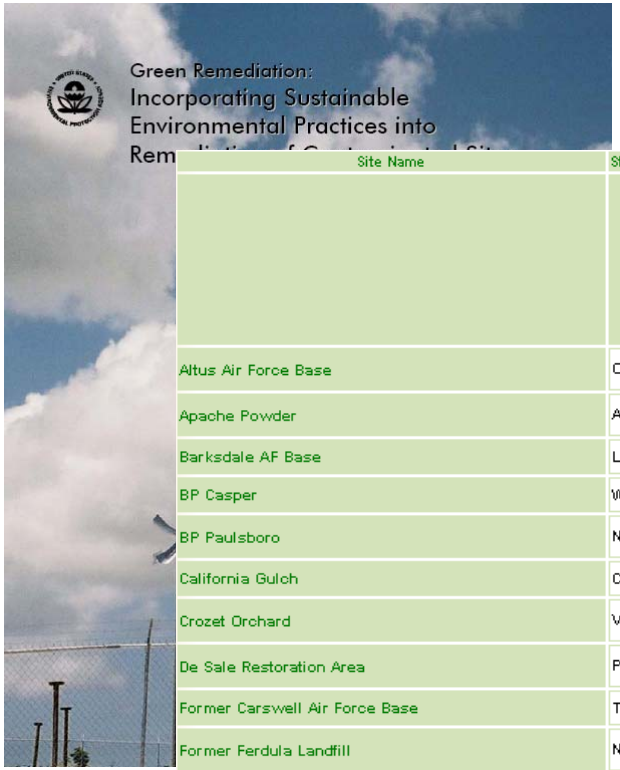
	Water Resource	Description of Quality of Water Used	Volume Used (1000 gallons)	Uses	Fate of Used Water
On-Site or Local Water Footprint	Public water supply				
	Extracted groundwater #1 Location: **~100 to creek** Aquifer: **shallow**	Classified as drinking water by State., but treatment needed prior to use. Other resources available	160,000	Extracted for treatment	Discharged to creek
	Collected/diverted storm water	Rain water quality	30,000	Prevented from recharging source area	Diverted to creek
	Unused table cells are hidden				
	Maximum drawdown of water table 100 feet from pumping locations		<0.5 feet	Sufficient to affect but not dewater wetlands.	
	Off-site water use	Unknown	3,200	Water for electricity production, GAC, lab analysis	Unknown

Closing Thoughts

- Focus on what questions we should be asking of a footprint analysis
- Remedy selection is not the end point
- Remember the 20/80 rule
- Tools, tools, tools – none are right/wrong
- Remember the goal, find ways to reduce the footprint of your cleanups

clu-in.org/greenremediation

- Technical guides
  - » Remedy fact sheets
  - » Evaluation tools
- Case studies
- Policy updates
- Conferences, training, seminars



Site Name	State	Core Elements						
		Energy Efficiency	Renewable Energy	Air Emission	Water	Land & Ecosystem	Materials & Waste	Stewardship
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		✓	✓	✓	✓	✓	✓
Former Carswell Air Force Base	TX						✓	✓
Former Ferdula Landfill	NY		✓	✓				
Former Nebraska Ordnance Plant	NE		✓	✓				
Former St. Croix Alumina Plant	VI		✓	✓			✓	
Fort Carson	CO		✓	✓	✓		✓	✓