CLU-IN Contaminated Site Clean-Up Information

Welcome to the CLU-IN Internet Seminar

Greener Cleanups - EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint

Delivered: August 10, 2011, 1:00 PM - 3:00 PM, EDT (17:00-19:00 GMT)

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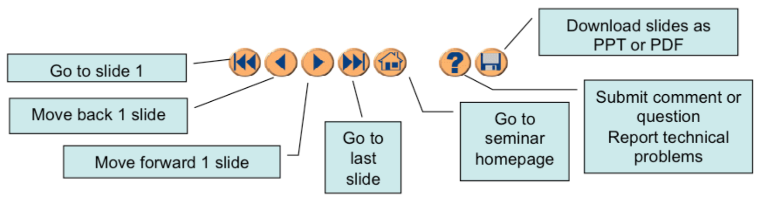

- This event is being recorded
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2

Although I'm sure that some of you have these rules memorized from previous CLU-IN events, let's run through them quickly for our new participants.

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With that, please move to slide 3.

Greener Cleanups - EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint

Carlos Pachon, OSRTI
Doug Sutton, Tetra Tech GEO
Karen Scheuermann, Region 9
Kira Lynch, Region 10
Hilary Thornton, Region 3

EPA

Seminar Outline

GOAL: Introduce EPA's draft methodology for environmental footprint analysis of remediation projects

- Introduction
- Methodology Overview
- Application of the Methodology
- Key Considerations for Interpreting Results
- Interpreting and Using the Results
- Next Steps
- Q&A

Methodology is in DRAFT form and will be posted for public feedback on September 9, 2011

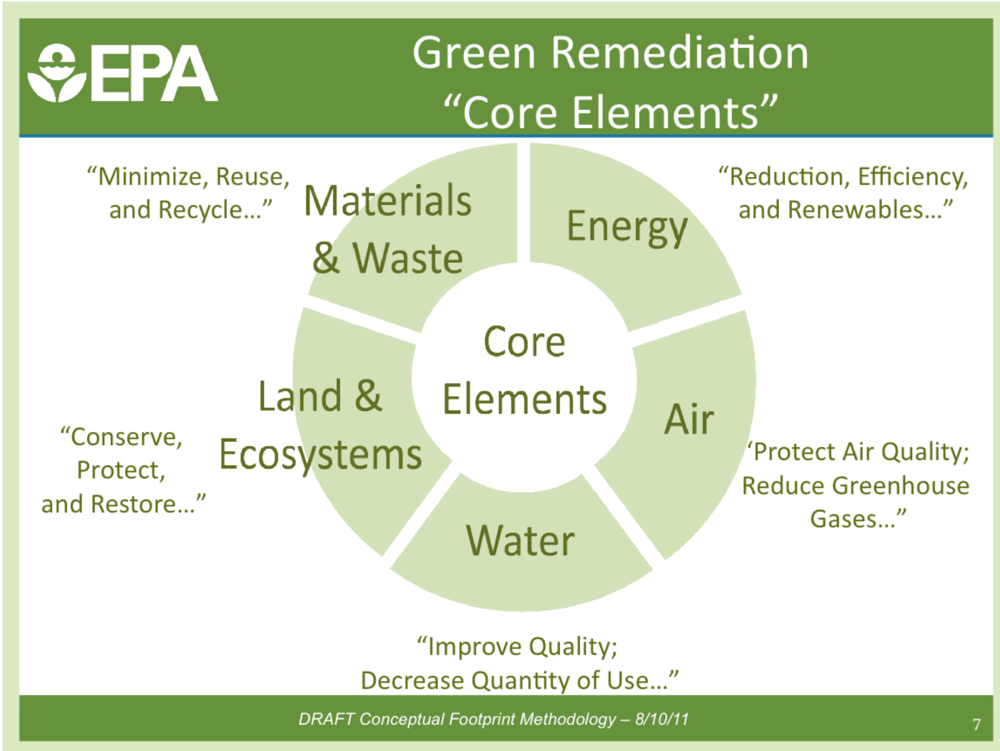
Introduction

Carlos Pachon

EPA

What is "Green Remediation"?

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


EPA
Green Remediation
“Core Elements”
“Minimize, Reuse, and Recycle…”
Materials & Waste
Energy
“Reduction, Efficiency, and Renewables…”
Core Elements
Land & Ecosystems
“Conserve, Protect, and Restore…”
Air
‘Protect Air Quality; Reduce Greenhouse Gases…”
Water
“Improve Quality; Decrease Quantity of Use…”
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7

EPA Green Remediation Policy

EPA OSWER "Principles for Greener Cleanups"

- "… we can optimize environmental performance and implement protective cleanups that are greener by increasing our understanding of the environmental footprint and, when appropriate, taking steps to minimize that footprint"
- Intended to improve the decision-making process for cleanup activities in a way that ensures protection of human health and the environment

National "Superfund Green Remediation Strategy"

- Aims to reduce the demand placed on the environment during cleanup actions and to conserve natural resources
- Specifies 40 actions undertaken by EPA's Superfund Program to implement green remediation measures within the CERCLA and NCP frameworks
- Establishes a process for measuring improvements to environmental outcomes of Superfund cleanups

Principles for Greener Cleanups

Consistent with existing laws and regulations, it is OSWER policy that all cleanups:

- Protect human health and the environment
- Comply with all applicable laws and regulations
- Consult with communities regarding response action impacts consistent with existing requirements
- Consider recommended five Green Remediation core elements

This is an incremental improvement in the implementation of EPA's cleanup programs

□

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The Role of Footprint Analysis

Footprint analysis is <u>not</u> required at any of our sites, but…

You can't manage what you don't measure.

Question:

How do we evaluate the environmental effects of remedy implementation?

Answer:

- Step 1: Develop metrics associated with the five core elements of Green Remediation
- Step 2: Develop a methodology for quantifying those metrics (i.e., the environmental footprint)
- Step 3: Apply the methodology during remedy design, implementation, O&M, and optimization

EPA — Green Remediation Metrics

Energy

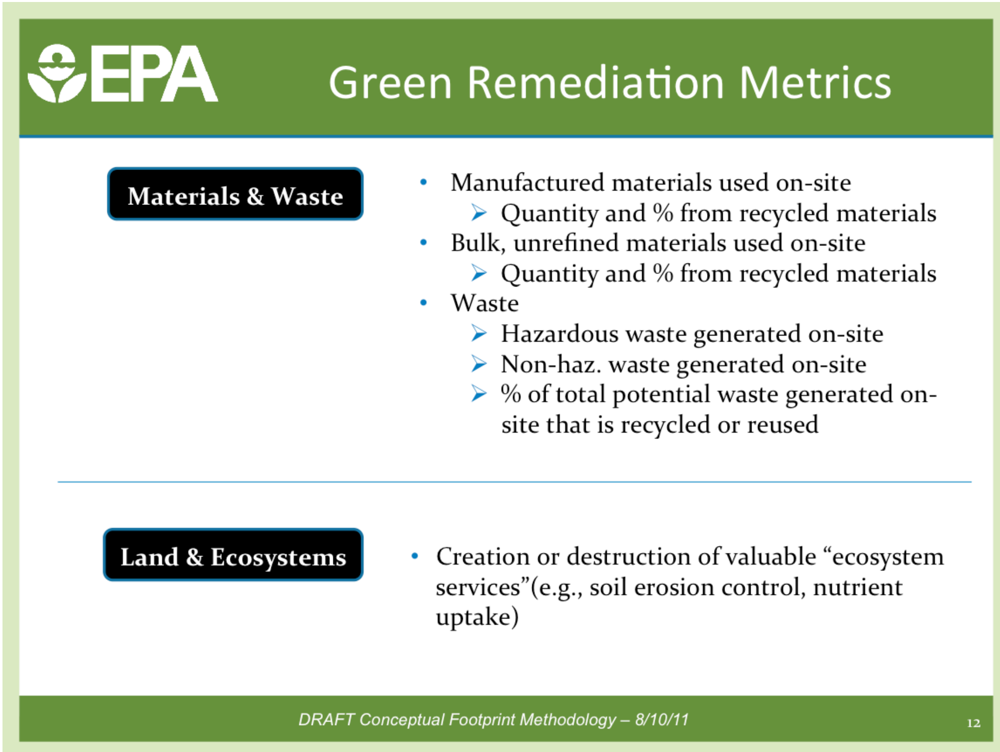
- Total energy used
- % of energy from renewable resources

Emissions

- Greenhouse gases
- Criteria pollutants (NOx, SOx, PM)
  - On-site emissions
  - Total emissions
- Hazardous air pollutants (HAPs)
  - On-site emissions
  - Total emissions

Water

- On-site water use (including public/potable water)
  - Quantity
  - Source of water
  - Fate of water
- Off-site water use
- Water table drawdown


EPA
Green Remediation Metrics
Materials & Waste
• Manufactured materials used on-site
➢ Quantity and % from recycled materials
• Bulk, unrefined materials used on-site
➢ Quantity and % from recycled materials
• Waste
➢ Hazardous waste generated on-site
➢ Non-haz. waste generated on-site
➢ % of total potential waste generated on-site that is recycled or reused
Land & Ecosystems
• Creation or destruction of valuable "ecosystem services"(e.g., soil erosion control, nutrient uptake)
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12

Methodology Applicability

Where and when is the methodology used?

- The methodology process and results are of value…
  - For all types of cleanup projects
  - For all cleanup programs
  - Throughout a cleanup project

How will EPA use it?

- Educate RPMs and EPA technical staff
- Conduct footprint analyses at its own sites when and where appropriate
- Evaluate footprint analysis submittals to EPA by other parties

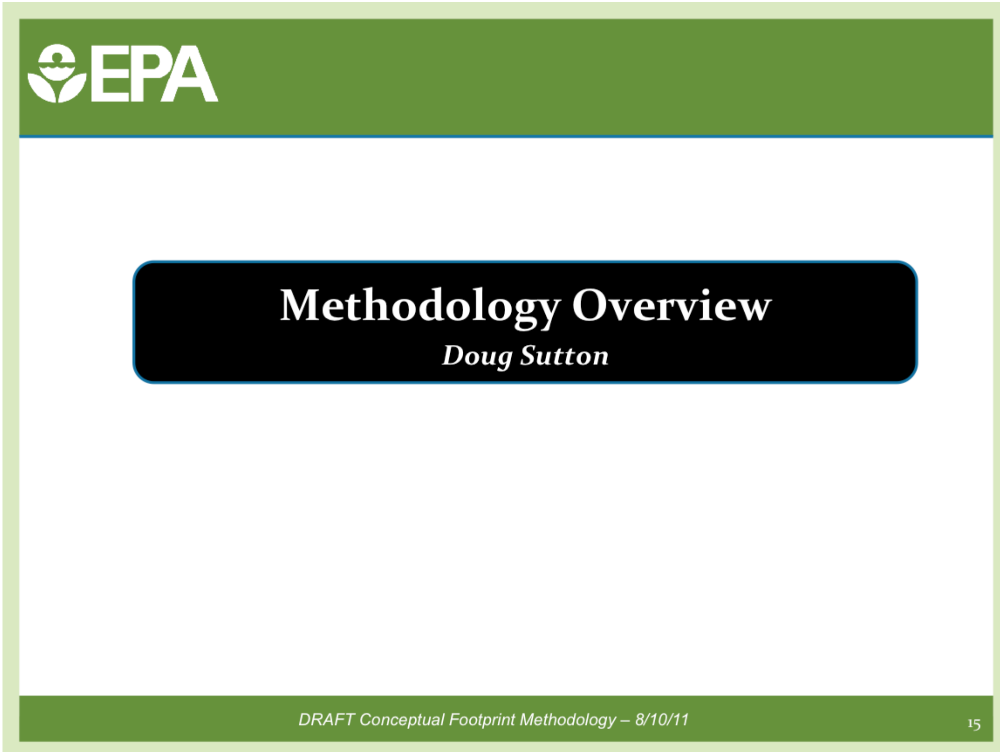
Methodology Applicability

Does the methodology call for life-cycle assessment (LCA)?

- No, it applies LCA-like concepts, but…
- It calculates the green remediation metrics but does not apply an "impact assessment"
- Materials and waste focus on on-site use and generation
- Energy, emissions, and water have fairly broad system boundaries

Does the methodology consider economic and societal factors?

- No, the methodology does not consider economic and societal factors
- Various economic and societal factors are considered during the cleanup process


EPA
Methodology Overview
Doug Sutton
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15

Materials & Waste Highlights

- Straightforward accounting of materials used on-site
  - Refined/manufactured (e.g., steel, chemicals)
  - Unrefined/minor processing (e.g., soil, sand, gravel)
- Straightforward accounting of waste generated on-site
  - Hazardous
  - Non-hazardous
  - Amount recycled or reused
- Example tables for organizing input and results

Much of module is rules of thumb or general assistance for creating an inventory of materials and waste

Water Highlights

- Straightforward accounting of on-site water use, considering site-specific factors
  - Source of water used
  - Quantity of water used
  - Use of water
  - Fate of water after use

Use of site-specific factors allows for development of site-specific water use metric

- Aquifer drawdown caused by remedy pumping
- Straightforward accounting of off-site water use (quantity only, not source, use, or fate)
  - Electricity generation
  - Materials manufacturing
  - Other off-site services

Calculated after electricity usage has been estimated

Much of module is assistance in estimating water use

Energy & Emission Highlights

- Three-step process
  - Inventory remedy materials and services
  - Calculate electricity and fuel use
  - Convert electricity, fuel, materials, and into energy and air metrics
- Organize calculations into four categories
  - On-site (similar to Scope 1 in EO 13514)
  - Electricity generation (Scope 2 in EO 13514)
  - Transportation (part of Scope 3 in EO 13514)
  - Other off-site materials and services (part of Scope 3 in EO 13514)
- Provides help estimating and calculating values
- Helps with determining appropriate level of detail
- Provides referenced footprint conversion factors

Uses some info from Materials & Waste and from Water Modules

Methodology Steps

Six Steps

1. Gather Remedy Information
2. Estimate materials & waste metrics
3. Estimate on-site water metrics
4. Estimate energy & emissions metrics
5. Estimate off-site water metric

Not discussed here… under development

6. Estimate land & ecosystem metrics

Application of the Methodology

Doug Sutton

Example Application

Application at a hypothetical P&T system

- P&T system designed to treat arsenic
- System expected to operate for 30 years
- Treatment plant removes arsenic through co-precipitation
  - Intensive chemical usage
  - Substantial waste generation
- Discharge treated water to the nearby creek
- Local electricity generation mix similar that of California
- Consider the following during a footprint at the design stage
  - System construction
  - System operation

1 Gather Remedy Information

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1

Gather Remedy Information

Remedy Item/Activity	Quantity/Information
Number, depth, and design of extraction wells	6-inch wells, 600 ft total
Length, size, and type of piping	3,000 ft of 6-inch HDPE
Extraction rate	700 gpm
Treatment plant construction	80 ft x 100 ft x 30 ft
Information for estimating utility use	Pumps, mixers, HVAC, lighting
Information for estimating waste generation	Influent loading
Information for estimating chemical use	Influent loading
Monitoring program (frequency, locations, parameters)	Annual, 100 wells, arsenic
Transportation distances	Various

Typical information from Feasibility Study, Design, Implementation/O&M, and Optimization

2 Estimate Materials & Waste Metrics

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2 Refined Materials

Material and Use	Common Quantity	Conversion Factor	% Recycled or Reused Content	Material Quantity (lbs) Recycled	Material Quantity (lbs) Virgin
Refined Materials (lbs)					
Wells – PVC & grout	400 ft	38 lbs/ft	0%	0	15,200
Piping	3,000 ft	7.5 lbs/ft	0%	0	22,500
Building steel	240,000 ft^3	1 lbs/ft^3	65%	156,000	84,000
Concrete reinforcing steel	40,000 ft^2	1.3 lbs/ft^2	65%	34,000	18,000
Cement portion of concrete	20,000 ft^3	25 lbs/ft^3	20%	100,000	400,000
Process equipment	50,000 lbs	1.25 lbs/lb	65%	41,000	21,500
Hydrogen peroxide (50%)	295,650 gal	4.96 lbs/gal	0%	0	1,467,000
Ferric chloride (37%)	1,368,750 gal	4.33 lbs/gal	0%	0	5,928,000
…	…	…	…	…	…
…	…	…	…	…	…
Refined Materials Subtotals (lbs):				**331,000**	**15,148,000**
Refined Materials Total (lbs):				**15,479,000**	
% of Refined Materials that is Recycled or Reused Content				**2%**	

Provided by User

Provided by Methodology

Calculated

Metric Results

② Unrefined Materials

Material and Use	Common Quantity	Conversion Factor	% Recycled or Reused Content	Material Quantity (tons) Recycled	Virgin
Unrefined Materials (tons)					
Wells –sand pack	200 ft	0.02 tons/ft	0%	0	4
Aggregate for concrete	741 cy	1.62 tons/cy	0%	0	1,200
Unrefined Materials Subtotals (tons):				**0**	**1,204**
Unrefined Materials Total (tons):				**1,204**	
% of Unrefined Materials that is Recycled or Reused Content				**0%**	

Provided by User

Provided by Methodology

Calculated

Metric Results

EPA

2 Waste

Waste or Used Material	Quantity
Recycled or Reused Waste (tons)	
Reused On-Site: None	**0**
Recycled or Reused Off-Site: None	**0**
Total Recycled or Reused Waste:	**0**
Landfilled Waste (tons)	
Hazardous Waste Disposed	
7,800 tons of dewatered precipitated metal sludge	**7,800**
Non-Hazardous Waste Disposed: None	**0**
Disposed Waste Total:	**7,800**
Total Waste:	**7,800**
% of Total Waste Recycled or Reused:	**0%**

Metric Results

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3 Estimate On-Site Water Metrics

3 Water

	Water Resource	Description of Quality of Water Used	Volume Used (1000's gallons)	Uses	Fate of Used Water
On-Site or Local Water Footprint	Public water supply	Potable	360,000	Blending polymer	Creek
	Extracted groundwater Aquifer: **"Shallow"**	Marginal quality	11,000,000	Treatment	Creek
	Surface water Intake Location: **None**	**None**			
	Reclaimed water Source: **None**	**None**			
	Collected/diverted storm water	**None**			
	Other water resource	**None**			
	Maximum drawdown of water table 100 feet from pumping	2 feet			
	Off-site water use	Electricity generation & materials prod.			

Completed as Step 5

EPA

3 Water

	Water Resource	Description of Quality of Water Used	Volume Used (1000's gallons)	Uses	Fate of Used Water
On-Site or Local Water Footprint	Public water supply	Potable	360,000	Blending polymer	Creek
	Extracted groundwater Aquifer: **"Ogallala"**	Vital Aquifer	11,000,000	Treatment	Creek
	Surface water Intake Location: **None**	**None**			
	Reclaimed water Source: **None**	**None**			
	Collected/diverted storm water	**None**			
	Other water resource	**None**			
	Maximum drawdown of water table 100 feet from pumping	2 feet			
	Off-site water use	Electricity generation & materials prod.			

Completed as Step 5

EPA

4 Estimate Energy & Emissions Metrics

EPA 4.1 Inventory

	Remedy Item/Activity	Quantity
Equipment Operation	Drill rig hours of operation	100 hours
	Electrical equipment for 30 years	Various
Transportation	Miles of personnel transport for 30 years	450,000 miles
	Ton-miles of materials transport for 30 years	10.3 million
	Empty return miles for trucks	520,000 miles
Materials (from Materials & Waste)	PVC for well casing	3,000 lbs
	Grout for well installation	12,200 lbs
	HDPE for piping	22,500 lbs
	Building, foundation, and process equipment steel	355,000 lbs
	Building foundation concrete	1,450 tons
	Chemical usage for 30 years	15,000,000 pounds
Off-site Services	Hazardous waste disposal for 30 years	7,800 tons
	Laboratory analysis for 30 years	$72,000

Additional information required beyond typical remediation information

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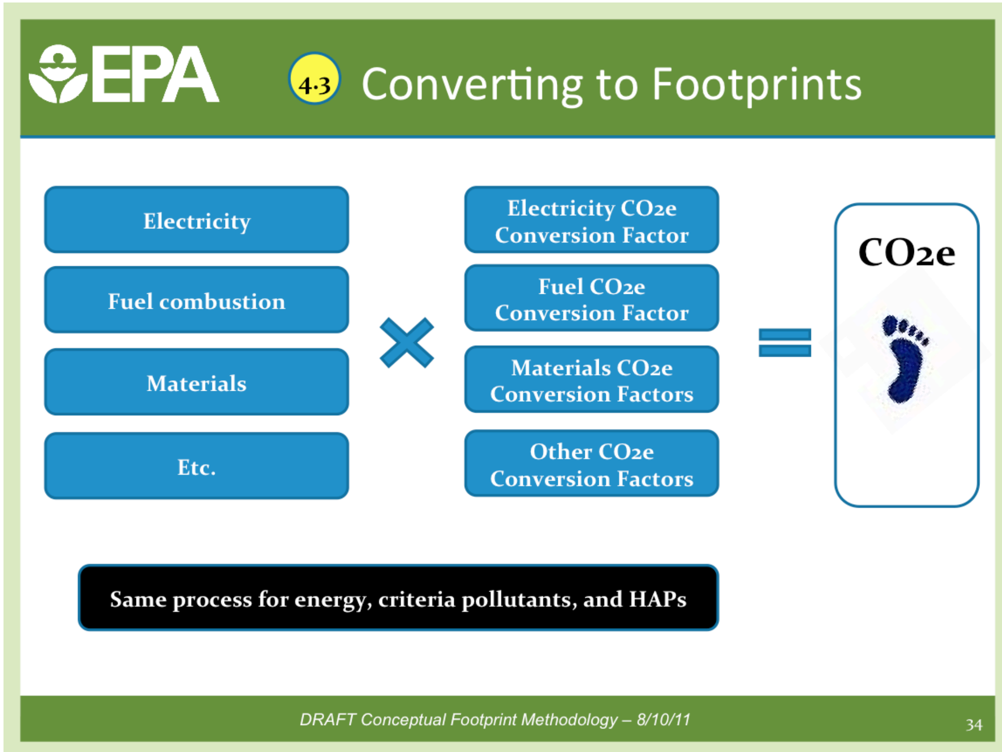
4.2 Energy Usage

Electrical equipment	→	Electricity usage
Natural gas equipment	→	Natural gas usage
Transportation and equipment	→	Fuel usage

Remedy Item/Activity	Energy Usage
Electrical use for treatment	20,000,000 kWh
Electrical use for extraction pump	13,000,000 kWh
Electrical use for lighting and HVAC	6,000,000 kWh
Natural gas use (building heat)	710,000 therms
Fuel use for materials transportation	175,000 gallons diesel
Fuel use for plant operators	30,000 gallons gasoline
Fuel use for drill rig	470 gallons diesel

** For display only… Table does not include all significant energy contributions for remedy*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4.3 Converting to Footprints
Electricity
Fuel combustion
Materials
Etc.
Electricity CO2e Conversion Factor
Fuel CO2e Conversion Factor
Materials CO2e Conversion Factors
Other CO2e Conversion Factors
CO2e
Same process for energy, criteria pollutants, and HAPs
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34

4.3 Converting to Footprints

	Inventory Component	Quantity	Energy Footprint (MMBtus)	CO2e Footprint* (lbs)
On-site	On-site elec. use Natural gas use	39,000,000 kWh 710,000 therms	133,000 73,000	0 8,700,000
Elec. Gen.	Electricity gen.	39,000,000 kWh	304,000	35,900,000
Transportation	Diesel Gasoline	175,000 gallons 30,000 gallons	24,000 3,700	4,500,000
Off-site	Materials Waste disposal Lab analysis Electricity trans. Public water Other	18,000,000 lbs 7800 tons $72,000 39,000,000 kWh 360,000,000 gals Other	125,000	31,700,000
		Total	**663,000**	**80,800,000**

** Only energy and CO2e footprints shown for example. Criteria pollutants, and HAPs not shown.*

5 Estimate Off-Site Water Metric

5 Off-Site Water

	Water Resource	Description of Quality of Water Used	Volume Used (1000's gallons)	Uses	Fate of Used Water
On-Site or Local Water Footprint	Public water supply	Potable	360,000	Blending polymer	Creek
	Extracted groundwater Aquifer: **"Shallow"**	Marginal quality	11,000,000	Treatment	Creek
	Surface water Intake Location: **None**	**None**			
	Reclaimed water Source: **None**	**None**			
	Collected/diverted storm water	**None**			
	Other water resource	**None**			
	Maximum drawdown of water table 100 feet from pumping	2 feet			
	Off-site water use	Electricity generation & materials prod.	98,000		

Electricity use and materials use multiplied by conversion factors from methodology

EPA

Environmental Footprint Summary

What does this mean?

What do I do with it?

Parameter	Footprint
Total Energy	663,000 MMBtu
% from Renewable Energy	0%
GHG Emissions	80,800,000 lbs
Total Criteria Pollutant emissions	660,000 lbs
On-site Criteria Pollutant emissions	7,600 lbs
Total HAP emissions	9,800 lbs
On-site HAP emissions	6 lbs
Public water use	360,000,000 gallons
Other on-site water use	Marginal impact
Off-site water use	98,000,000 gallons
Refined materials use (% from recycled material)	15.5 million lbs (2%)
Unrefined materials use (% from recycled material)	1,204 tons (0%)
Hazardous waste	7,800 tons
Non-hazardous waste	0 tons
% of total on-site waste recycled or reused	0%

Key Considerations for Interpreting the Results

Karen Scheuermann

Questions to Ask Before Applying the Analysis

What will results be used for?

- Remedy evaluation?
- Remedy design?
- Remedy optimization?
- Tracking effectiveness of BMPs?

What parameters are of the greatest importance?

- Energy? Emissions? Waste? Water?
- Parameters associated with local effects? With global effects?

What are likely sources of information?

- Annual energy and utility usage?
- Detailed design specifications?
- Conceptual remedy design?

Questions to Ask During the Analysis

What activities/materials can be omitted?

- Materials used in small amounts
- Infrequent activities

What are the greatest sources of error or uncertainty?

- Undetermined aspects of remedy design
- Remedy timeframes
- Footprint conversions factors

How can analysis address these uncertainties?

- Evaluate alternative designs
- Perform sensitivity analyses
- Conduct additional research

Document the sources of error and uncertainty and how they are addressed

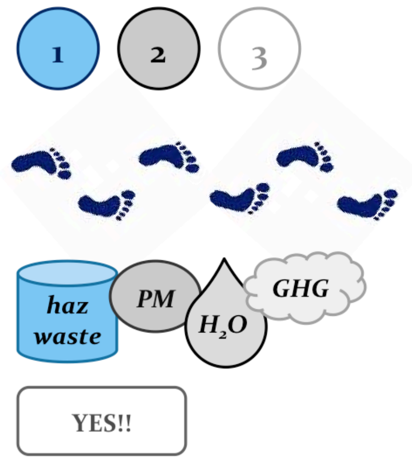
Questions to Ask After the Analysis

How accurate are the results?

What is a big footprint?

What parameters are of greatest importance?

Can I use the results to target areas for improvement?



How accurate are the results?

1. **Think about uncertainties in overall scope.**

In our case study, the pump and treat is expected to continue 30 years.

2. **Uncertainty in major contributors to the footprint.**

For greenhouse gas emissions…
- electricity use
- chemical use
- natural gas for building heat

3. **Be aware of estimates in the calculations.**

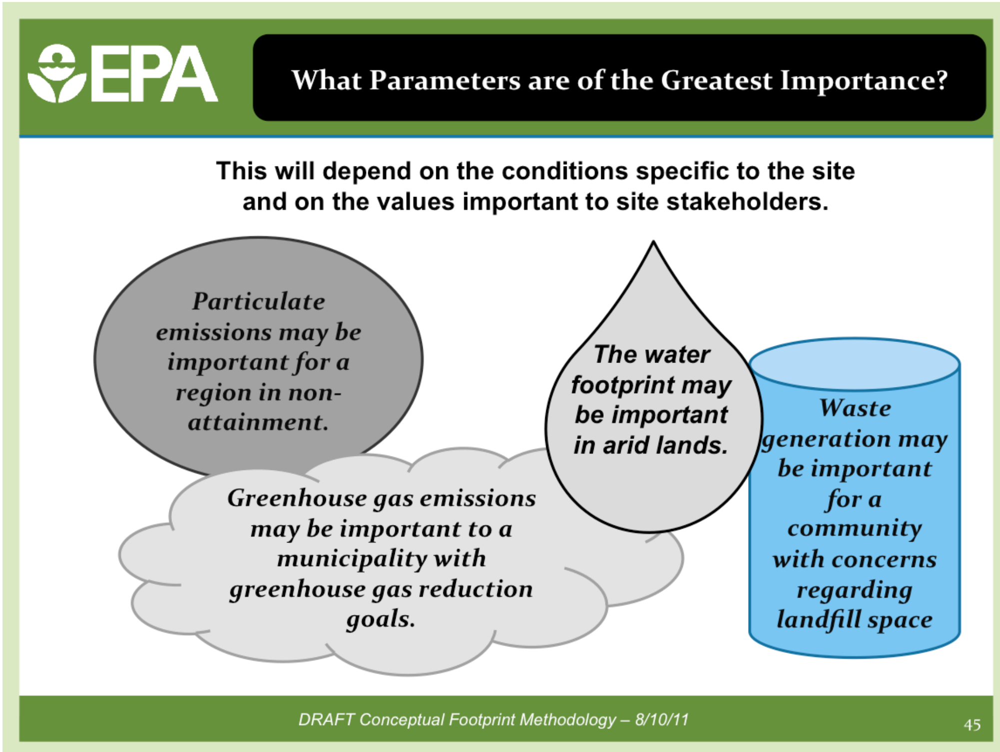
- footprint conversion factors
- fuel usage estimates
- transportation distances

Keep in mind…. The results of footprint analyses are estimates to help guide future footprint reduction actions, and are not exact numbers!

What is a Big Footprint?

- What is the right benchmark for comparison?
- How does the footprint for a particular remedy compare to…
  - footprints of similar remedies in your organization's portfolio?
  - your organization's overall footprint?
  - footprints of other similar remedies?
- Are there goals that you or your organization set for…
  - magnitude of footprint reductions
  - percentage footprint reduction
- Are there footprint reduction goals that have been recommended for your organization by another party?

A small percentage reduction of a large footprint can be a large magnitude reduction


EPA
What Parameters are of the Greatest Importance?
This will depend on the conditions specific to the site and on the values important to site stakeholders.
Particulate emissions may be important for a region in non-attainment.
The water footprint may be important in arid lands.
Waste generation may be important for a community with concerns regarding landfill space
Greenhouse gas emissions may be important to a municipality with greenhouse gas reduction goals.
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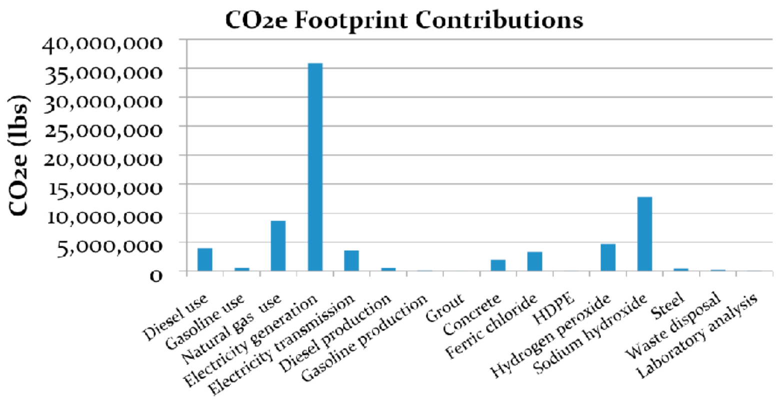
45

Can I Use the Results to Target Areas for Improvement?

YES!!

A footprint analysis can give you results that highlight the key contributors.



Interpreting and Using the Results

Kira Lynch

Primary Uses of Results

Reporting numbers to those who are asking for them

Assistance in reducing footprints

Mr. Supervisor:

Our

= Too Big

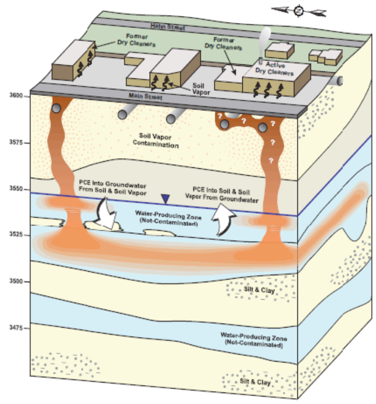
Sincerely,
Mr. Green

We will primarily discuss footprint reduction

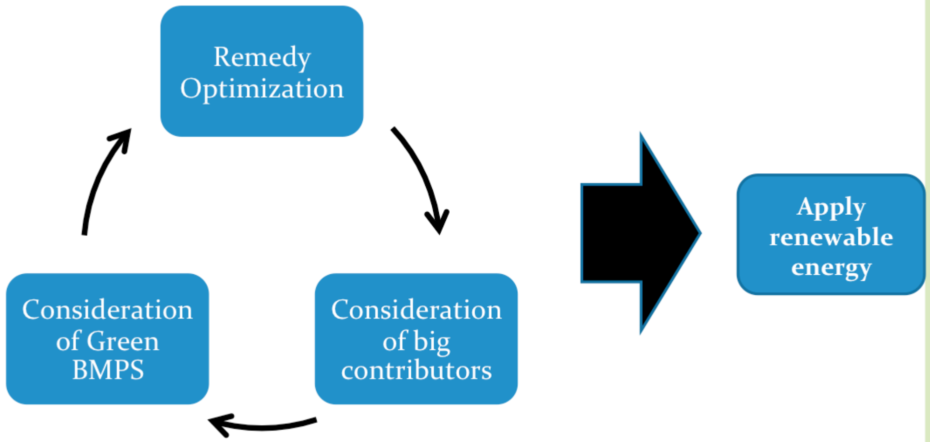
Approaches to Footprint Reduction

Small environmental footprints are consistent with good science and engineering

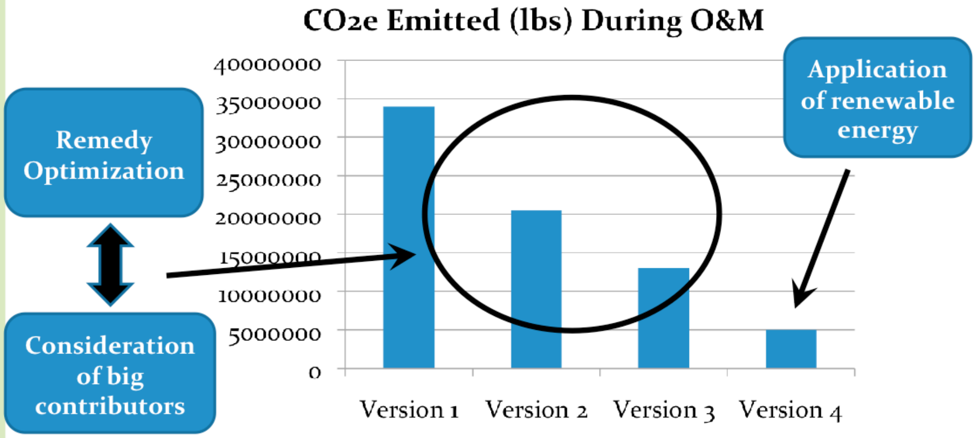
- Minimizing footprints and large footprint reductions come from…
  - An accurate conceptual site model (CSM)
  - Well-characterized source areas and contaminant plumes
  - Appropriate remedy selection
  - Sound engineering
  - Streamlined performance monitoring



Effective Approach for Footprint Reduction

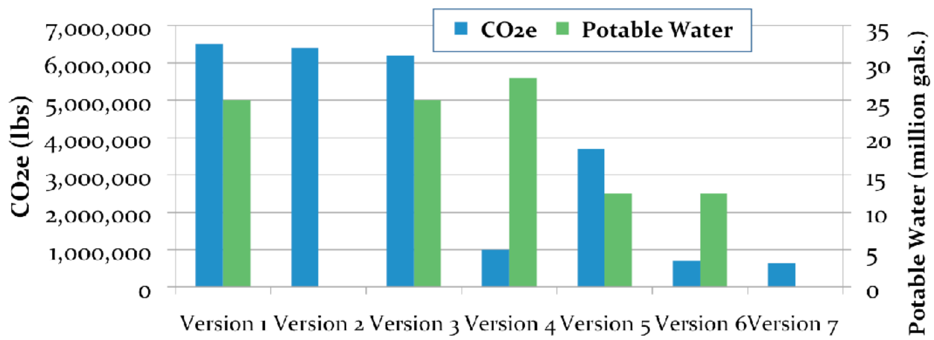


Example at a P&T System



Version 1 – *Baseline: air stripping → GAC → discharge to sanitary sewer*
Version 2 – *Enhance air stripping and eliminate GAC*
Version 3 – *Enhance air stripping and eliminate GAC and discharge to surface water*
Version 4 – *Version 3 plus application of renewable energy*

Example for Bioremediation Remedy



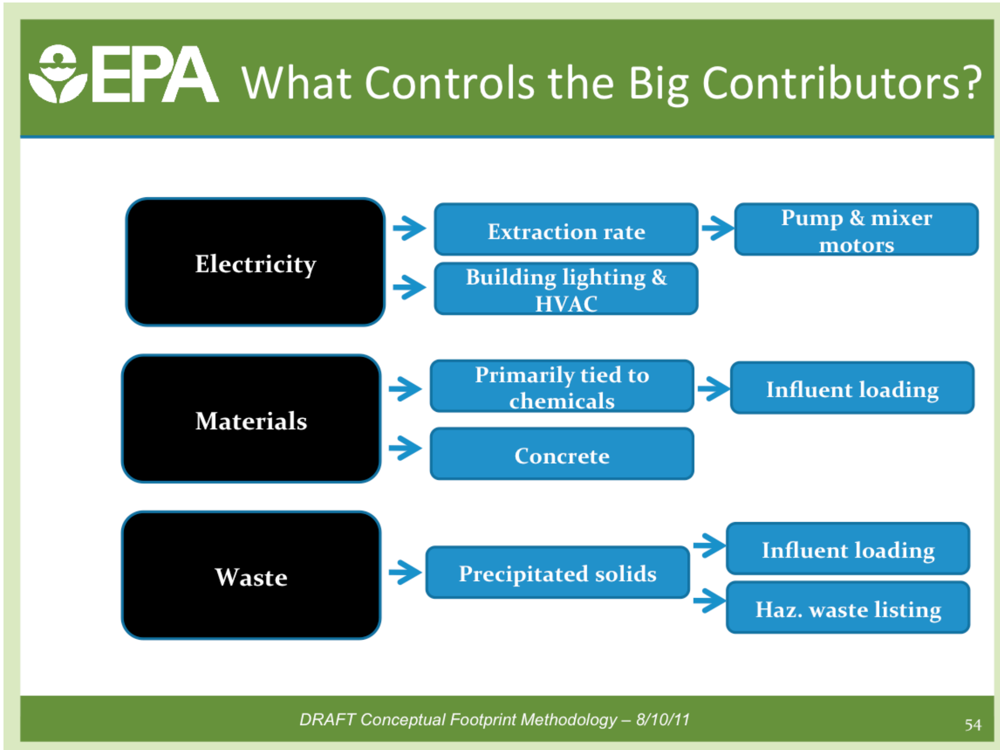
Version 1 – *Baseline injection of emulsified vegetable oil with potable water*
Version 2 – *Injection with extracted groundwater*
Version 3 – *Use of biodiesel for materials transport and drill rig operation*
Version 4 – *Use appropriate "off-spec" or waste food-grade product for bioremediation nutrient*
Version 5 – *Refine CSM and confirm source area is 50% smaller*
Version 6 – *Refine CSM and use appropriate "off-spec" product for nutrient*
Version 7 – *Refine CSM, use off-spec product for nutrient, use extracted groundwater, use biodiesel*

EPA

Back to our Example P&T System

What are the big contributors?

Footprint Parameter	Primary Contributors
Total Energy	Electricity & Materials
GHG Emissions	Electricity & Materials
Criteria Pollutant emissions	Electricity & Materials
HAP emissions	Electricity & Materials
Public water use	Polymer blending
Other on-site water use	GW Extraction
Off-site water use	Electricity & Materials
Refined materials use & % from recycled material	Chemicals
Unrefined materials use & % from recycled material	Aggregate for concrete
Hazardous waste	Influent loading
Non-hazardous waste	N/A


EPA
What Controls the Big Contributors?
Electricity
Extraction rate
Pump & mixer motors
Building lighting & HVAC
Materials
Primarily tied to chemicals
Influent loading
Concrete
Waste
Precipitated solids
Influent loading
Haz. waste listing
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54

Addressing Big Contributors

CSM Related

- Can we optimize the extraction rate?
- Can source removal/stabilization reduce influent concentration?

Process Optimization

- Are there changes to substitutes for process components that can reduce electricity or chemical use?
- Are motors oversized or throttled back? Are variable frequency drives used where appropriate?

Addressing Big Contributors

Traditional Energy Efficiency

- Can we adjust building HVAC and lighting operation?
- Can we use more efficient HVAC and lighting technologies?

Managing Waste

- Are there other chemicals (preferably a waste stream) that we can use?

Green BMPs & Renewable Energy

- Can we use renewable or alternative energy?
  - On-site renewable energy
  - Purchased renewable energy
  - Combined heat and power

What about the Small Contributors?

Transportation

Transportation is not always a "small" contributor

- Carpooling → reduce gasoline usage by 10,000 gallons
- Mix chemicals on-site → reduce diesel usage by ~20,000 gallons
- Waste to local facility → reduce diesel usage by ~53,000 gallons

Total energy reduction of ~11,000 MMBtu (~2% of total energy use by remedy)

Small percentage reduction but large magnitude

Small % reductions may be lost in a footprint analysis where other contributors dominate. → **Use BMPs to achieve these reductions, and use footprint methodology to help quantify reductions**

Next Steps

Hilary Thornton

Public Feedback

Document Available for Public Feedback

September 9, 2011

↓

Period of Public Feedback Closes

November 8, 2011

↓

Finalize methodology

December 31, 2011

Is There a Tool Available?

EPA

- EPA does not anticipate developing/maintaining a tool for this methodology.
- EPA has footprint spreadsheets it uses that are generally consistent with the methodology.
- The spreadsheets will be consistent with the final methodology and made publicly available on www.cluin.org/greenremediation.
- Once the methodology is final, EPA Green Remediation Coordinators and the EPA Engineering Forum will be available to answer questions regarding the methodology.

Is There a Tool Available?

Other Organizations

- Tools have been developed by other organizations, examples include…
  - SiteWise™
  - Sustainable Remediation Tool (SRT™)
  - GolderSET
  - BalancE3
  - Life-cycle assessment tools
  - GS-Rx

- The tools are not standardized or benchmarked as of yet
- The tools may or may not be consistent with methodology
- The tools may become consistent with methodology

EPA will not endorse individual tools

Training and Tech Transfer

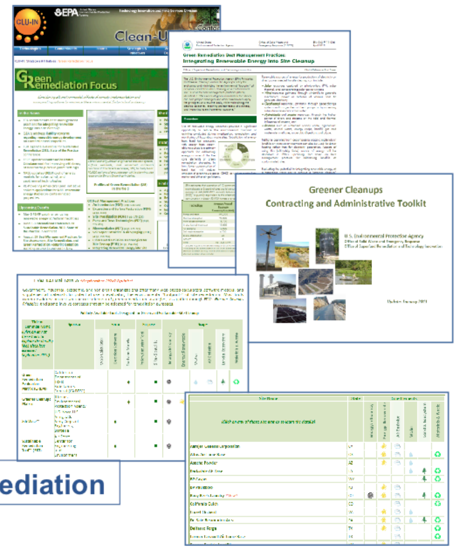
Training in the 10 EPA Regions

Training via internet seminars
www.cluin.org

Additional example applications and case studies will be posted
www.cluin.org/greenremediation

Other GR Resources & Tools

- Website
- BMP toolkit
- Contracting toolkit
- Footprint evaluation tools & examples
- Site profiles (28)
- HQ & regional policies or strategies
- News, training, & conferences



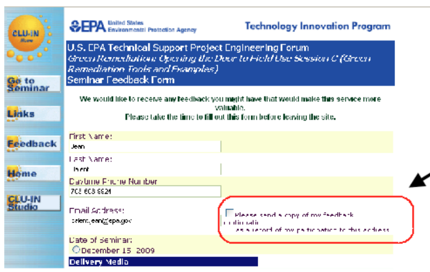
www.clu-in.org/greenremediation

EPA

Questions

Resources & Feedback

- To view a complete list of resources for this seminar, please visit the **Additional Resources**
- Please complete the **Feedback Form** to help ensure events like this are offered in the future



Need confirmation of your participation today?

Fill out the feedback form and check box for confirmation email.