Sustainable Remediation Forum (SURF)
SURF 6: March 3 and 4, 2008
Aiken, South Carolina

This meeting marked the sixth time that various stakeholders in remediation—industry, government agencies, environmental groups, consultants, and academia—came together to develop the ability to use sustainability concepts in remedial decision-making. Previous meetings were held on the dates and locations listed below. Previous meeting minutes are available at www.ibackup.com. The username is surfarchive, and the password is surf.

- SURF 1: November 13, 2006 (Wilmington, Delaware)
- SURF 2: February 8, 2007 (Wilmington, Delaware)
- SURF 3: May 10, 2007 (Washington, DC)
- SURF 4: August 22 and 23, 2007 (Newark, New Jersey)
- SURF 5: November 28 and 29, 2007 (Sacramento, California)

SURF 6 was held in Aiken, South Carolina on March 3 and 4, 2008. Those individuals that participated in the two-day meeting are listed in Attachment 1 along with their contact information.

Meeting Opening

The meeting began with Dave Ellis (DuPont) welcoming all participants and thanking Ralph Nichols of the Savannah River National Laboratory (SRNL) for hosting the meeting. Dave noted that this meeting would be more action oriented than previous meetings, focusing on the white paper development and sustainability exercise results.

Ralph Nichols (SRNL) kicked off the meeting, welcoming all SURF members, discussing meeting logistics, and describing how SRNL works to use natural resources (e.g., sun, wind, barometric pressure changes) to clean up environmental contamination. Ralph also provided the group with a brief history of the Savannah River site and the current role of The Center for Hydrogen Research, where the meeting was held. During the meeting and much to the delight of participants, the Center showed off a hydrogen-powered pickup truck.

Mike Rominger (meeting facilitator) reminded participants of the meeting theme: "How might we move from talk into action in sustainable remediation?" Mike thanked the Meeting Design Team for their work in planning the meeting agenda. SURF 6 Meeting Design Team members were Kathy Adams (Writing Unlimited), Dave Ellis (DuPont), Paul Hadley (California Department of Toxic Substances and Control), Gary Maier (EarthTech), Chuck Newell (GSI Environmental), Ralph Nichols (SRNL), Mike Rominger (On-Board Services), Maile Smith (Northgate Environmental Management), and Dave Woodward (EarthTech).

The draft mission statement from the February 2007 meeting was read as follows: "To establish a framework that incorporates sustainable concepts throughout the remedial action process that provides long-term protection of human health and the environment and achieves public and regulatory acceptance." Participants were reminded that this mission statement served as a starting point and could be revised as SURF develops and moves forward.

Introductions were made, and attendees participated in an exercise that explored environmentally friendly or "green" products. The meeting agenda was available in hard copy for those participants attending the meeting in person.

Finally, Mike reminded everyone of the need to abide by anti-trust regulations. He also discussed meeting logistics and ground rules (e.g., expectation that attendees will be active participants, show respect for others, appreciate and encourage divergent opinions, refrain from marketing, and be familiar with previous meeting minutes so the meeting can focus on new information). Mike also noted that it is assumed that nothing discussed or presented contains confidential information. Prior to the meeting, export control compliance was verified.

At SURF 5 (November 2007), participants discussed how to make SURF carbon neutral. Efforts in "sustainable neutral behavior" continued at this meeting. Name badges and tent cards were reused from SURF 5, and participants were asked in advance to bring their own mug or cup for beverages. In addition, plastic and trash used during the meeting were recycled. These efforts are ongoing and will continue at future meetings.

News Items

Participants discussed the following news items at the beginning of the meeting:

- Two sessions on sustainable remediation are scheduled at the Battelle conference in Monterey, California. The conference will be held from May 19 through May 22.
- The Environmental Protection Agency (EPA) Green Remediation web site is up and running at **http://clu-in.org/greenremediation/index.cfm**. The web site provides technical information with links to publications and papers about green remediation, profiles of green strategies, and sustainability initiatives.
- The sustainable remediation pilot that has been highlighted at previous SURF meetings is still progressing. Preliminary remedy selections have been made by DuPont and EPA for three areas at a DuPont site in Virginia. A streamlined corrective measures study is currently being developed to capture the decisions that have been made during meetings between the EPA and DuPont.
- Sustainable remediation efforts continue in the United Kingdom and Europe:
    - SURF UK is continuing with a parallel effort to SURF efforts in the U.S., focusing on several work areas. SURF members in the U.S. continue to interact with SURF UK members to ensure collaboration where appropriate and exchange ideas.
    - Platform papers on sustainable remediation will be presented at the ConSoil 2008 meeting, which is being held from June 3 through June 6 in Milan, Italy.
- The Air Force Center for Engineering and the Environment (AFCEE) is sponsoring a Technology Transfer Workshop with the theme of "Focus on the Goal—Remedies in Place by 2012." The workshop will be held March 25 through March 28 in San Antonio, Texas, and Chuck Newell (GSI Environmental) will present a session on how to build sustainability into remediation. Chuck gave his presentation to SURF 6 participants, and a summary of his presentation is provided in these notes.

Presentations

As noted previously, the meeting was designed to answer the following question: "How might we move from talk into action in sustainable remediation?" Presentations were designed to address this question. Each presentation and subsequent discussion is summarized briefly in the subsections below.

Building Sustainability into the Air Force Remediation Process

Chuck Newell (GSI Environmental) presented the capabilities and preliminary results of a tool developed by GSI Environmental that helps U.S. Air Force (USAF) remediation professionals incorporate sustainability concepts into their decision-making process. The AFCEE is considering sustainability as a metric in response to an Executive Order issued by President Bush last year that requires that federal agencies operate in a sustainable manner. The tool is intended to be used as a planning tool for the future implementation of remediation technologies at a particular site, as well as an evaluation tool to optimize remediation technology systems already in place. Specifically, the tool allows users to estimate sustainability metrics for the following technologies: soil vapor extraction, excavation, enhanced bioremediation, and pump and treat. To make the tool more user friendly, the framework consists of two tiers, each requiring a different level of information and effort.

Chuck presented the preliminary results of a pump-and-treat case study where the tool was used to evaluate sustainability. Currently, the site is scheduled to continue pumping and treating a large plume for 12 additional years (until 2020). Metrics for carbon emissions, energy used, lost resource service (i.e., soil and groundwater), and economic cost were calculated over the 12-year estimated project lifetime. Then, all metrics were converted to cost to give a common baseline for all four metrics. Presentation slides are provided in Attachment 2.

Discussions focused on the lost resource metric and the potential to reuse remediated water for drinking water purposes. One participant noted that sites with existing pump-and-treat systems can be converted to a geothermal heating or cooling system, which takes advantage of the sometimes large quantities of water in these systems. Chuck noted that in situ treatment over a large area similar to that of case study presented would not be sustainable. Participants discussed (as we have in previous meetings) the difficulty of weighing or scaling different sustainability metrics (e.g., lost resources vs. carbon emissions). While net environmental benefit analysis can help, it does not include all of the sustainability metrics that we are addressing.

Green Remediation and the Use of Renewable Energy Sources for Remediation Projects

Amanda Dellens (EarthTech) presented the results of her research project with the EPA in which she identified cleanup projects that used or are using renewable, sustainable energy sources and/or alternative fuels for site remediation. Amanda defined "green remediation" as the practice of considering environmental impacts of remediation activities at every stage of the remedial process in order to maximize the net environmental benefit of a cleanup. Considerations include selection of a remedy, energy requirements, efficiency of on-site activities, and reduction of impacts on surrounding areas.

Amanda's research identified 15 projects where renewable energy was used to power remedial systems. Nine of the projects used solar power (i.e., photovoltaics), four projects used wind power, one used landfill gas, and one used recycled vegetable oil as a fuel to power equipment. Several of these sites used a combination of energy sources to achieve site-specific goals. The most common contaminated media at these sites was groundwater, and the majority of the sites employed pump-and-treat systems. Other small uses of renewable energy at sites included irrigation and data collection. The study findings generally suggest that the use of renewable energy sources to power remediation systems is gaining ground but currently focuses on pump-and-treat systems. Findings also indicate, however, that numerous opportunities exist for expanded integration of renewable energy sources in remedy selection and design. Presentation slides are provided in Attachment 3.

Discussions focused on identifying the financial return on the energy invested for these projects. One participant mentioned a paper that was recently published on the return on energy invested, focusing on ethanol[1]. Although Amanda's research did not document the pounds of contaminant removed, participants agreed that that information would be valuable to evaluating the efficiency of the cleanup. One participant asked about the operation and maintenance costs of using renewable energy sources. These costs were not within the scope of the research project and, therefore, were not tabulated. Although these costs would vary from site to site and energy source to energy source, they may be useful in determining if renewable energy could be used as a polishing step to achieve regulatory levels in various media. Another participant asked if the energy, resources, and emissions associated with producing the "green" elements (e.g., solar panels) were included in the assessment. All agreed that it is necessary to be cautious of the unintended consequences of using alternative energy sources.

Participants also discussed the need to integrate energy efficiency at the design stage and the reality that building engineering safety factors into a design increases the energy consumption of the system. One participant noted that one way to conduct greener remediation without changing equipment is to buy green power from a publicly owned utility. Another participant spoke of the potential for the thermal energy in pumped groundwater to reduce the energy requirements.

United Kingdom and European Perspectives on Sustainable Remediation

In his presentation, Paul Nathanail (University of Nottingham) compared the United Kingdom (SURF UK) and the European Commission perspectives on sustainable remediation. In Europe, there is a growing recognition of the scale of contaminated soil problems and less of a desire to ensure cleanup, let alone sustainable cleanup. In addition, there is also a desire to decouple waste legislation and soil remediation within a general risk-based framework. European Commission initiatives for sustainable development attempt to accelerate technology innovation and encourage new firms to enter the market in order to lower costs and increase competitiveness. European Commission structural funds provide a major driver for remediation; however, a growing skills shortage is hindering both practitioners and regulators.

Paul noted that the complex and rigorous metrics of sustainable remediation based on life cycle analysis have been developed but are too unwieldy to be pragmatic. Partial approaches, including a focus on eco-efficiency akin to green remediation, are more likely to gain acceptance and be put into practice. Paul showed examples of a Pythagorean model as one way to integrate

[1] Hammerschlag, R. 2006. "Ethanol's Energy Return on Investment: A Survey of the Literature 1990-Present." *Environ. Sci. Technol. 40*(6):1744-1750.

sustainability across social, environmental, economic, and institutional dimensions assuming that the social, economic, and environmental aspects are normalized to some baseline (e.g., natural attenuation, excavation and disposal). Presentation slides are provided in Attachment 4.

Discussions focused on how to provide a unified valuation of the economic, environmental, and societal elements of sustainability. It was noted that to date, societal elements have not been scored per se in sustainability evaluations to date. Paul mentioned that the challenge lies not in scoring the elements, but rather in the weighting of the good and bad within each of the elements. In his experience, the stakeholders have determined which factors were important.

Status of Sustainable Remediation White Paper

At SURF 5 (November 2007), participants discussed a new effort within SURF to write a white paper about sustainable remediation. The draft title of the white paper is *Integrating Sustainability Principles, Practices, and Metrics into Remediation Projects*, and a draft outline of the paper was distributed to participants at SURF 5. The purpose of the white paper is to collect, clarify, and communicate the thoughts and experiences of SURF members on sustainability in remediation. All participants agreed that the development of the paper should be a transparent process.

Also at SURF 5, facilitators for major chapters were assigned, and participants volunteered to help specific facilitators based on the chapter topic and their area of interest or expertise. At SURF 6, participants gathered into breakout groups according to their assigned chapters. New SURF members joined a breakout group based on the chapter topic and their area of interest or expertise. Attachment 5 provides the most recent listing of volunteers for each chapter; individuals interested in contributing to a chapter should contact the appropriate chapter facilitator. Chapter facilitators (or their representative) led the breakout group discussions, and each group used the face-to-face time to discuss reorganization of the draft outline and the appropriate content for their chapter.

When chapter facilitators reported back the progress made during the breakout session, it was clear that there is a potential for overlap between chapters and a need to coordinate closely to avoid duplication of effort. As a result, Dave Ellis (DuPont) will set up regular meetings with chapter facilitators to ensure effective communication between all involved and to track progress. In addition, participants discussed whether the white paper should have a global perspective or be more focused on the U.S. All agreed that a global perspective was necessary for benchmarking purposes.

Throughout the meeting it also became evident that a written introduction would help chapter teams write their chapter. Therefore, Paul Hadley (California Department of Toxic Substances and Control) and Dave Ellis (DuPont) will write a draft introduction that includes a brief definition of sustainable remediation, SURF's mission, and a brief overview of each chapter. It was noted that the definition of sustainable remediation will be important to chapter teams as they begin to write their chapter. One participant reminded others that sustainable remediation is a process, not a product.

Sustainable Remediation Exercise

At SURF 5 (November 2007), participants agreed that it would be helpful to discuss applying sustainable concepts to a hypothetical site to explore the diversity of the thought processes involved. Dave Ellis (DuPont), Dick Raymond (TerraSystems), Chuck Newell (GSI Environmental), and Paul Favara (CH2MHill) worked as a team to develop the hypothetical site and distributed details about the site to SURF members prior to the meeting. Specific SURF members were asked to examine the sustainability aspects of at least one of four technologies and be prepared to discuss their methods and results at the SURF 6 meeting. Members were asked to assume that the technology would be implemented by itself (vs. combined with other technologies). Although it is clear that this assumption may not be true in the real world, members were asked to adhere to this restriction for the purposes of completing the exercise. The four technologies were as follows: pump and treat, in situ thermal treatment, accelerated reductive dechlorination, and excavation. Chuck Newell (GSI Environmental), Paul Favara (CH2MHill), and Gordon Burnett (URS Diamond) provided key technology parameters for specific technologies. Creativity and diversity in the approaches and metrics applied were highly encouraged.

During SURF 6, participants gathered into four panels. New SURF members joined a panel based on the technology and their area of interest or expertise. Attachment 6 lists the four panels and their members. Panel members discussed the exercise and then reported back to the group. The four panel discussions revealed the following common themes, unresolved questions, and new approaches to consider when integrating sustainable concepts into remediation:

- ❑ Common Themes
  - Several members expressed value for a tiered evaluation approach that can estimate direct emissions quickly as an alternative to a more comprehensive sustainability evaluation that includes the added impact of indirect emissions associated with all of the consumed materials.
  - Results provide further support for on-site treatment technologies that destroy the contamination.
  - Oversimplification of parameters or the problem reduces unique elements of specific sites.
  - The synergy of discussing different ideas with a variety of people is important during the process so as not to focus on just one parameter in the evaluation (e.g., carbon dioxide).
- ❑ Unresolved Questions or Open Issues
  - How do we include and balance societal benefit and local community benefit (e.g., providing local employment) in sustainability?
  - How do we address lost resources?
  - How do we balance the tradeoffs for remedies that are fast but energy intensive (e.g., thermal treatment) vs. those remedies that are implemented over a long time frame but use very little energy (e.g., accelerated reductive dechlorination)?

  - Where do we factor in uncertainty in the evaluation?
  - Should we consider renewable energy credits?
- New Approaches
  - Consider holding a sustainability tailgate at the beginning of a project to get the project team generating ideas about how to achieve a more sustainable remedial solution.
  - Consider using the TRACI model, a life-cycle analysis tool, to categorize the impacts of chemicals (e.g., smog). Although no evaluation is provided in the model, it allows the user to bucket items according to value and proved to be a simple, effective filter during the sustainability evaluation.
  - Consider SO_2 and NO_x emissions for energy-intensive operations.

Path Forward

The following path forward items were identified at the meeting:

1. The next meeting will be hosted by SURF member Stephanie Fiorenza in Houston, Texas, the week of June 9, 2008. Additional meeting logistics will be forwarded as they become available. A draft agenda will be developed by the Meeting Design Team and will be circulated via e-mail. Active feedback and suggestions are encouraged.
2. Based on feedback at the meeting, volunteers for the design team are as follows: Dora Chiang (EarthTech), Paul Favara (CH2MHill), Stephanie Fiorenza (BP), Stella Karnis (Canadian National), Ralph Nichols (SRNL), Dick Raymond (Terra Systems), and Dave Woodward (EarthTech). Additional members are welcome. Meeting Design Team members should expect to spend about eight hours on the effort between now and the next meeting.

Attachment 1
SURF 6 Participant Contact Information

SURF 6 Participant Contact Information

Full Name	Affiliation
Kathy Adams	Writing Unlimited
Pierre Beaudry	Golder Associates
Erica Becvar*	Air Force Center for Engineering and the Environment
Susan Block	South Carolina Dept. of Health and Environmental Control
Brandt Butler	URS Corporation
Jeff Caputi	Brown and Caldwell
Dora Chiang	EarthTech
David Curnock	United Technologies Corporation
Amanda Dellens	EarthTech
Carol Dona	U.S. Army Corps of Engineers
Dave Ellis	DuPont
Paul Favara	CH2M Hill
Ben Foster	LFR, Inc.
Paul Hadley*	California Dept. of Toxic Substances and Control
David Hagen*	Haley Aldrich
Mark Harkness*	General Electric
Mike Houlihan	Geosyntec Consultants
Bill Hyatt*	K&L Gates
Stella Karnis	Canadian National
Lowell Kessel*	GEO Inc.
Maryline Laugier	Malcolm Pirnie, Inc.
Janine MacGregor*	New Jersey Dept. of Environmental Protection
Ted Millings	South Carolina Dept. of Health and Environmental Control
Paul Nathanail*	University of Nottingham
Chuck Newell	GSI Environmental
Ralph Nichols	Savannah River National Laboratory
Dick Raymond	Terra Systems
David Reinke*	Shell Global Solutions
Mike Rominger	On-Board Services
Tiffany Swann	GSI Environmental
Jake Torrens*	Geomatrix Consultants
Dan Watts	New Jersey Institute of Technology
Elizabeth Wells*	San Francisco Water Board
Dave Woodward	EarthTech

Notes:

* Individual participated via conference call

Attachment 2
Building Sustainability into the Air Force Remediation Process

HQ US Air Force

Building *Sustainability* into the Air Force Remediation Process

Charles J. Newell PhD, PE, DEE

SuRF 6

March 4, 2008

EarthTech A tyco International Ltd. Company

GSI ENVIRONMENTAL

Sustainability in AF Remediation:
Catalyst

3919

Federal Register
Vol. 72, No. 17
Friday, January 26, 2007

Presidential Documents

Title 3—
The President

Executive Order 13423 of January 24, 2007

Strengthening Federal Environmental, Energy, and Transportation Management

By the authority vested in me as President by the Constitution and the laws of the United States of America, and to strengthen the environmental, energy, and transportation management of Federal agencies, it is hereby ordered as follows:

Section 1. *Policy.* It is the policy of the United States that Federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner.

Sustainability in AF Remediation:
Sustainability Paradigms

New Remediation Paradigm

- Examples of Existing Metrics
  - CERCLA Nine Criteria
  - Risk and Economic Cost
- New Metrics
  - CO_2 Emissions
  - Energy Usage
  - Resource Service
  - Materials Consumption

Goal: Add New Metrics to the Mix

Key Point: New Metrics Represent Externalities Not Captured in Economic Cost or Other Metrics

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Sustainability in AF Remediation:
Project Objective

The Problem…

Current management of contaminated sites does not fully consider sustainability concepts.

A Solution…

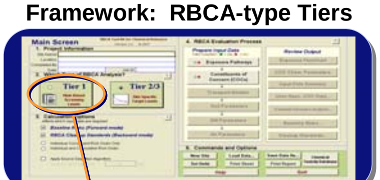
Develop tool to help AFCEE environmental professionals incorporate sustainability concepts into their remediation decision making process (e.g., PBEM, RRM, RPO) for

i) planning future remediation implementation

ii) optimizing operating remediation sites

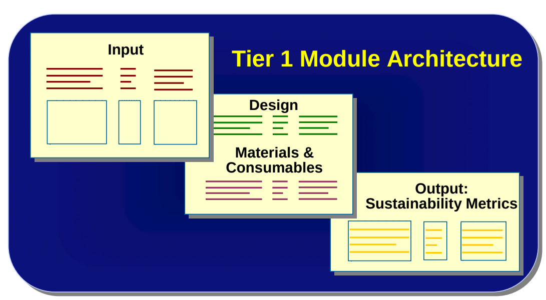
Sustainability in AF Remediation:
Tool Development

Framework: RBCA-type Tiers



Calculations Based on Time Required:	Tier 1	Tier 2
	"Rules of Thumb"	User-entered design information from detailed design
	1-2 hrs	1-2 days

Sustainability in AF Remediation:
Tool Development



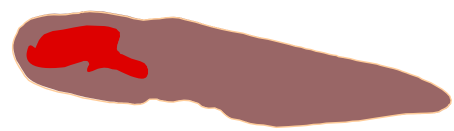
Sustainability in AF Remediation:

Tool Development

Tier 1 Key Sustainability Metrics

- **Carbon Emissions**
- **Energy Use**
- **Lost Resource Service**
  - ***- Soil***
  - ***- Groundwater***
- **Economic Cost**

Test Case for Large and Dilute Plume

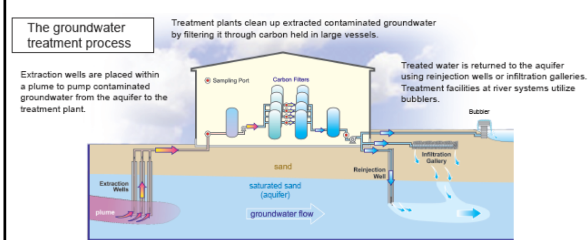


Test Case Plume

Source Stats:
- **Two sources: Fire Training Area and Sewage Treatment Plant**
- **42,000 tons soil treated by Thermal treatment in 2000**

Plume Stats:
- **Chlorinated ethenes (PCE, TCE)**
- **24,000 ft long by 2,600 ft wide**
- **Plume from 50 ft to 150 ft below grade**
- **Original plume mass: 620 lbs**
- **Current plume mass: 276 lbs**
- **Max. concentration: 137 ug/l PCE**

Pump & Treat



Pump & Treatment System

1999 - 2007:
- **3 Extraction Wells @ 1,200 gpm**
- **Treatment via Activated Carbon**
- **Two Infiltration Galleries**

2008 - 2020:
- **Changed to 1 Extraction Well @ 425 gpm**

Key Point: Estimated Project Lifetime: 12 more years to 2020.

Four Metrics

CO_2 Emissions (Lifetime)

Pumping Water:	**313 Tons**
Power for Tmt. :	**254 Tons**
GAC Regen. :	**1,907 Tons**
TOTAL	**2,474 Tons**

Power Used (Lifetime)

TOTAL	**845,000 kWh**

Four Metrics

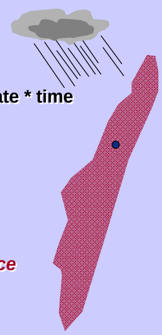
Lost Resource Service

-Opinion 1: New Jersey NRDA:

- -Lost GW Service = Plume area * recharge rate * time
- -For this plume: ~ 80 billion gallons
- *-But this water not "destroyed"*

-Opinion 2: Plume Volume

- - Lost GW Service: ~ 45 billion gallons
- *- But all this water cannot be removed at once*



Four Metrics

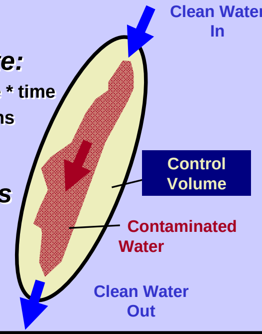
Lost Resource Service

-Opinion 3: Pumping Rate:

- -Lost GW Service = Pumping rate * time
- -For this plume: ~ 3 billion gallons
- *-But clean water is reinjected*

-Opinion 4: Plume Status

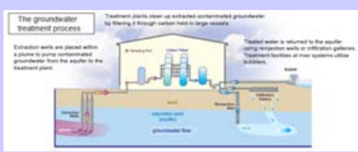
- *-For stable plume, no net water contaminated after plume reaches stability*



Four Metrics

Economic Cost

-Approximately $17 million to run existing Pump & Treat system over project lifetime



Four Metrics - "Right Brain"

CO_2 Emissions……………………2,474 tons
Energy Used…………………..845,000 kWh
Lost Resource Service..0 to 80 billion gals
Economic Cost…………………..$17 million

Key Point: All metrics calculated over the 12-year estimated lifetime of the project.

Four Metrics - "Left Brain"

CO_2 Emissions…………………………$12,400
Power Used…………………………….$84,500
Lost Resource Service……$0 to $16,000,000
Economic Cost……………………$17,000,000

Convert all metrics to cost gives a common baseline for all four metrics.
Note that some metrics are counted twice.

Key Conversions (preliminary):
CO_2 Emission Offset: $5/ton. Water Value: $0.20/1000 gallons

Sustainability in AF Remediation:
Tool Development

Sustainability Scenarios

"When you *spin scenarios*, you end up with an array of plausible futures – usually three to five possible stories of how the future will unfold for you, your organization, your community, or whatever you are focusing on.

The idea is *not* to decide *which of these tales is right*. Rather, the idea is to create an array of plausible futures.

The point of scenario-spinning is to help us "*suspend our disbelief*" in all possible futures, so that we can see the possibilities with clear eyes." (Flower, 1997)

Shell Oil Scenarios: | ***"Scramble" vs. "Blueprint"***

Sustainability in AF Remediation:

Tool Development

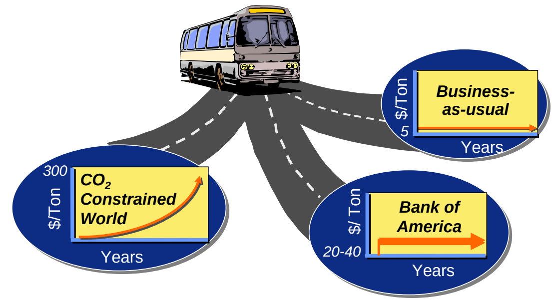
Sustainability Scenarios

"The **Scramble** scenario is...where self-interest predominates initially. Voters in the West and in the developing world are unwilling to make radical changes in lifestyle. Politicians concentrate on trying to optimise within their own national perspectives. As a result there is global competition for resources and little attention paid to cutting energy consumption. Naturally, this will lead to new international political tensions and greenhouse gas emissions continue to climb.

The **Blueprints** scenario is...more benign. Governments accept that climate change and skyrocketing global energy demand require a co-ordinated solution on the Kyoto model. This starts slowly – think the recent Bali accords – but gathers momentum in time to avoid the worst prospects for global warming and energy wars. New energy technology also plays a big role."

(From http://www.strategykinetics.com/2008/01/another-view-of.html)

Three Carbon Emission Scenarios



"Left Brain" Under *Carbon Constrained World* Scenario

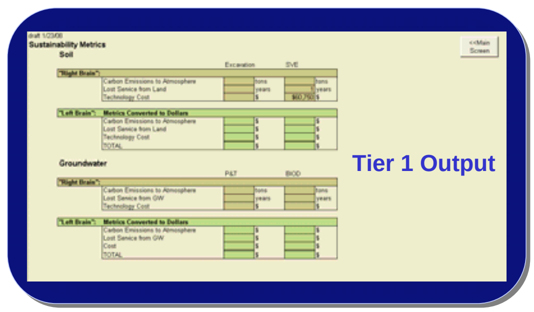
CO_2 Emissions……………………….$247,000
Energy Used……………………...…….$84,500
Lost Resource Service……$0 to $16,000,000
Economic Cost……………………$17,000,000

Convert all metrics to cost gives a common baseline for all four metrics.
Note that some metrics are counted twice.

Key Conversions (preliminary):
CO_2 Emission Offset: $100/ton. Water Value: $0.20/1000 gallons

Sustainability in AF Remediation:

Tool Development



Tier 1 Output

Sustainability in AF Remediation:

Tool Development

Project Timeframe

Task 1
Compile and Test existing tools; Select relevant modules

Task 2
Develop architecture of prototype on MS Excel Platform

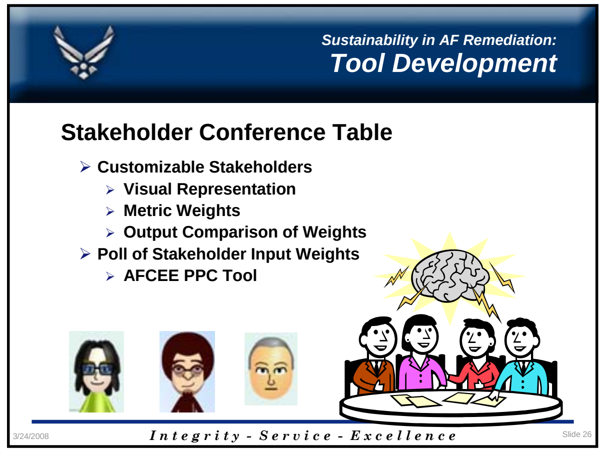
Task 3
Test prototype with real AF project data

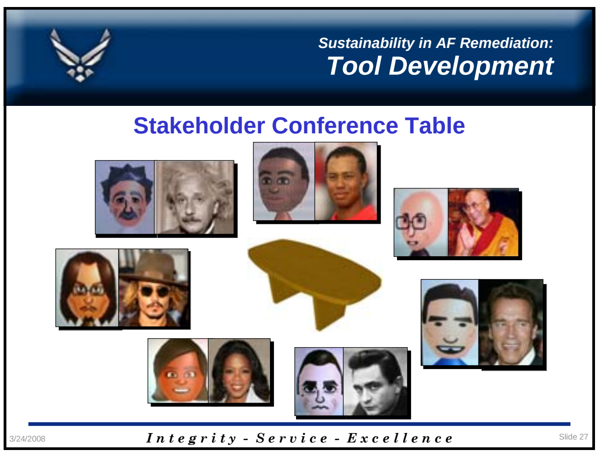
Task 4
Earth Tech, GSI, and AFCEE
1) Integrate into AF peer review and RPO processes.
2) Present at conferences and other related meetings.

October 2007 — April 2008 — September 2008

Questions / Discussion


EXTRA SLIDES
25


Sustainability in AF Remediation:
Tool Development
Stakeholder Conference Table
Customizable Stakeholders
Visual Representation
Metric Weights
Output Comparison of Weights
Poll of Stakeholder Input Weights
AFCEE PPC Tool
3/24/2008
Integrity - Service - Excellence
Slide 26


Sustainability in AF Remediation:
Tool Development
Stakeholder Conference Table
3/24/2008
Integrity - Service - Excellence
Slide 27

Attachment 3
Green Remediation and the Use of Renewable Energy Sources for Remediation Projects

Green Remediation and the Use of Renewable Energy Sources for Remediation Projects

SuRF Meeting - March 5, 2008

Amanda D. Dellens
Earth Tech, Inc. – Alexandria, VA

Project Description

- National Network for Environmental Management Studies Fellowship Program
  - Applicants include graduate and undergraduate students in fields of environmental science and engineering
  - Funded by a grant from the US EPA
  - Project began in May 2007 and concluded in August 2007
  - Sponsored by
    - Office of Solid Waste and Emergency Response (OSWER)
    - Office of Superfund Remediation and Technology Innovation (OSRTI)

Presentation Outline

- Purpose of Project
- Green Remediation
- Energy Sources
- Findings
- Benefits
- Areas of Opportunity
- Conclusions
- Questions

Purpose of Project

- Identify sites across all regions and cleanup programs (Superfund, RCRA, Brownfields, UST, Federal Facilities) that are using:
  - renewable energy sources to power remediation systems
  - alternative fuels to operate equipment and machinery
- Identify trends in renewable energy use and opportunities for advancement of the practice
- Document the findings in a Report

Green Remediation

- The practice of considering the environmental effects of a remedial strategy (i.e. the remedy selected and the implementation approach) early in the process, and incorporating options to maximize the net environmental benefit of the cleanup
- Identify opportunities to increase sustainability and efficiency
  - Remedy Selection
  - On Site Activities
- The goal is not to change the remedy selection criteria, but to incorporate sustainability into the process

Alternative Energy Sources

- 9.56% of U.S. energy production comes from hydroelectric, geothermal, solar, wind, and biomass (EIA Annual Energy Review 2006)
- Renewable energy systems can supply power to local utility grids and use net metering (where allowed)
- Landfill Gas is generally used to generate electricity on site, *but not specifically for remediation*
  - 424 operational landfill gas energy projects as of April 2007 (LMOP)

Alternative Energy Sources

Energy Source	Applications	Cost (Generating Capacity)	Cost (Use)	U.S. Production
Solar	Pump and Treat, SVE, Data Collection, Irrigation, General Energy Production	$8-$10 per watt	$0.04-$0.07 per kWh	120 MW (PV) 2,339 MW* (CSP) 198 MW (Solar Heating)
Wind	Pump and Treat, SVE, General Energy Production	$2-$4 per watt	$0.20-$0.30 per kWh	11,961 MW
Landfill Gas	General Energy Production	$2-$3 per watt	$0.07-$0.09 per kWh	1,195 MW
Biofuels	Equipment/Vehicle Operation	$1.04 per gallon	$3.31 per gallon	1.39 billion gallons per year

*2006 Contract Potential

Research: Projects Identified

- Fifteen sites currently using renewable energy
- Four sites planning the use of renewable energy
- Sites represent 8 of the 10 EPA regions (Regions 5 and 10 not represented)
- Superfund, RCRA, Brownfields, Removal Response, Federal Facilities, and state programs

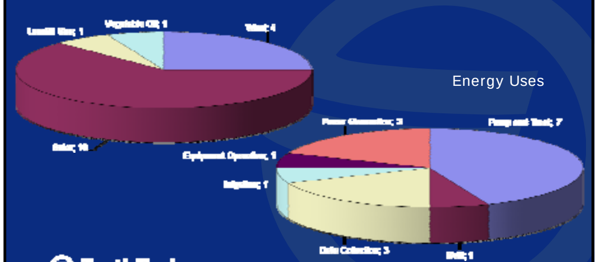
Findings

- Solar and wind are the most common sources used to provide power to remediation systems
- Remediation systems are usually supplemented with power from renewable energy for smaller energy requirements
  - Low flow pumps
  - Data collection or monitoring
  - Irrigation
- Renewable energy systems ranged from 200W to 275kW (not including power generation sites)
- Limitations cited by sites included:
  - Lack of financial resources
  - Community acceptance

Renewable Energy Sources and Uses

Energy Sources

Energy Uses



Renewable Energy System Capacity

Site	Energy Type	Capacity (kW)
Altus AFB	Solar	0.20
Crozet Township Arsenic Site	Solar	0.39
Apache Powder	Solar	1.44
Pemaco	Solar	3.00
Lawrence Livermore National Lab Site 300	Solar	3.20
BP Paulsboro	Solar	275.00
Aberdeen Proving Ground O- Field	Solar	**
Raytheon Beech Aircraft Site	Solar	**
Savannah River Site	Solar	**
Former Nebraska Ordnance Plant	Wind	10.00
FE Warren AFB	Wind	1320.00
Massachusetts Military Reservation	Wind	1650.00
Getty Gasoline	Wind	**
St. Croix Alumina Facility	Wind/Solar	10 scfm @ 45psi 0.83kW (solar)
OII Landfill	LFG	420.00
Grove Brownfield	Vegetable Oil	**
** Capacity data not available		

Benefits

- Environmental Benefits
  - Reduced emissions of greenhouse gasses (CO_2) and other air pollutants (SO_X, NO_X)
  - Reduced dependency on fossil fuels
  - Reduced impact on local ecosystems and communities
- Economic Benefits
  - Reduced construction costs for remote sites where utility power is unavailable
  - Potential trading of carbon emission credits provides incentives to retrofit systems
  - Federal tax credits for renewable energy use

Achieved Benefits and Cost Savings

Examples of emissions and cost savings achieved at various sites (cited from personal communication with project managers)

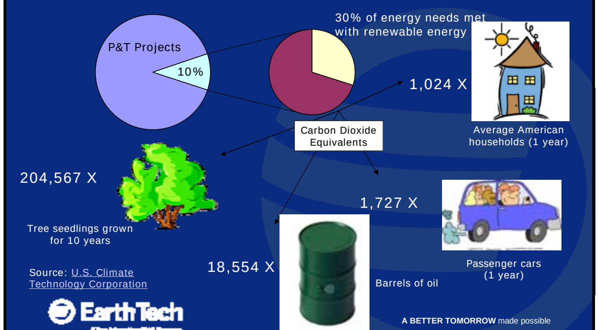
Altus AFB Altus, OK	200 W PV system	$1,000 per year plus capital costs (power lines)
BP Paulsboro Paulsboro, NJ	275 kW PV system	571,000 lbs/year CO_2 1,600 lbs/year SO_2 1,100 lbs/year NO_X
Pemaco Maywood, CA	3 kW PV system	4,311 lbs/year CO_2 3 lbs/year SO_2 4 lbs/year NO_X
FE Warren AFB Cheyenne, WY	1,320 kW wind farm (power generation)	$3 million over 20 years 4,866 tons/year CO_2
OII Landfill Monterey Park, CA	6 LFG microturbines	$400,000 per year

Potential Environmental Benefit: Example

- 545 operational pump and treat systems (ASR 12th ed. Draft)
- 10% of these systems use renewable energy for 30% of their energy needs
- 12,838,469 kWh of energy consumption generated from renewable energy
- 8,794.36 tons of CO_2 per year

An average pump and treat system uses 778,089 kWh per year
DOE estimates 1.37 pounds of CO_2 emissions for each kWh generated

Potential Environmental Benefit: Example Cont'd: CO_2 Reductions



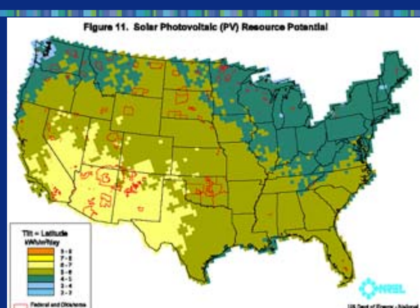
Source: U.S. Climate Technology Corporation

Areas of Opportunity

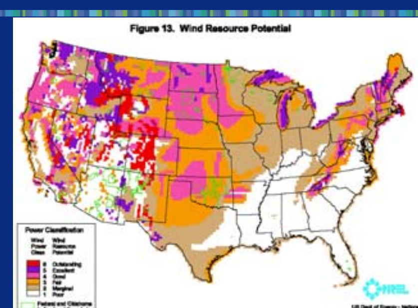
- Remote locations where electricity is not available or feasible
- Use for systems with small energy requirements
- Possibility of selling carbon credits from decreased emissions (RGGI & CAP)
- Commercially available technologies
- Continuing research

390kW PV array at Crozet Orchard Site

Areas of Opportunity: PV Resource Potential (DOE)



Areas of Opportunity: Wind Resource Potential (DOE)



Conclusions

- The most common applications of renewable energy at remediation sites are pump and treat systems (low flow pumps)
- Using sites for energy production is beneficial in terms of sustainability
- Opportunities are available for increased use of renewable energy
- The market is responding to demand for sustainability and the practice of using renewable energy is growing
- Continue to incorporate renewable energy choices into remedy selection process

Acknowledgements

- U.S. Environmental Protection Agency
  - Office of Superfund Remediation and Technology Innovation
    - Carlos Pachon
    - Scott Fredericks
    - Jim Woolford
  - Office of Solid Waste and Emergency Response
    - Barry Breen
    - Nancy Allinson
  - Support from EPA regional offices and RPMs

Questions?

Report available online at:

http://clu-in.org/download/studentpapers/Green-Remediation-Renewables-A-Dellens.pdf

Also at EPA's recently launched Green Remediation website:

http://clu-in.org/greenremediation/tab_c.cfm

Attachment 4
United Kingdom and European Perspectives on Sustainable Remediation

UK and European perspectives on 'Sustainable Remediation'

Paul NATHANAIL
Professor and Head of Land Quality Management, University of Nottingham;
Director, CABERNET

A favour: I am looking for 2-3 sites to visit with 12 masters students in the San Diego area on Thursday 13 and Friday 14 March 2008 – YES next week! paul@lqm.co.uk

Who are you listening to?

Dimensions of a definition

- Socially: acceptable? Progressive?
- Environmentally: beneficial? Benign?
- Economically: affordable? Minimal?

- Boundaries – space, time, institutional, SHE

exclusions

- Sustainable development - Brundtland
- Sustainable redevelopment – www.cabernet.org.uk
- Sustainable regeneration – www.rescue-europe.com
- Sustainable reclamation

Where are we now?

- Recognition of scale of contaminated soil problem
- Desire to ensure remediation is sustainable
- Key EU legislation:
  - Soil Framework Directive stalled
  - Water Framework Directive being implemented
- UK Part 2A ('superfund')
- Prevent or mitigate 'pollution'
- Tension between desire to improve remediation and deliver new housing quickly and cheaply on previously developed land (aka brownfield)
- Lack of willingness to pay for sustainability

Where do we say we would like to be?

- Decouple waste legislation and soil remediation
- Systematic consideration of sustainability and long term benefits
- Generalization of risk-based approaches
- Performance-based standards
- More process based remediation
- Quicker remediation (cf six phase soil heating to remove TCE from former tools site; now being developed for housing)
- Cheaper remediation
- Move away from dig & dump
- UK SURF

Where do we say we would like to be?

SURF UK is an initiative taken forward by CL:AIRE to *"bring together stakeholders in the remediation industry to develop the concepts of sustainable remediation decision making".*

The preliminary VISION STATEMENT of SURF UK is:

"Develop a framework in order to embed balanced decision making in the selection of the remediation strategy to address land contamination as an integral part of sustainable development".

Where do we say we would like to be?

SAGTA/ NICOLE definition of sustainable remediation (3 march 2008):

"embedded balanced decision making to select the strategy to address land [and/or water] contamination as an integral part of sustainable development".

BUT focus is on contamination not risk; issue more than just selection: need to remediate and mode of implementation, validation and residual liabilities are also significant

Where are we heading for?

- ETV objectives – key criteria for assessment
  - Speed up innovation
  - Faster market entrance
  - Short ETV procedure
  - Low costs
  - Increase SME competitiveness
- Remediation Technologies Promotion Programme (RTPP):
  - raise awareness about **sustainability and eco-efficiency**
  - increase knowledge and expertise
- 2M new homes by 2016; 3M by 2020
- Skills shortage
- Ca 30% of available brownfields is public surplus land
- Public sector procurement and land disposal policy holds the key

ETV: Environmental Technology Verification

Drivers?

- (Co) funds much remediation through structural and other funds
- (Co) funds research
- Modernised thinking
  - Life-cycle & "impacts" thinking
  - Apply subsidiarity
  - Prevent rather than cure
- RTPP
  - Improving Markets Conditions
  - Performance Targets
  - Mobilisation of Financing (grants and loans)
  - Market based Instruments: economic incentives
  - Green Public Procurement
  - Awareness Raising and Training
- Detailed Quantitative Risk Assessment widely accepted
- Part 2A: Cost benefit analysis on enforced remediation

Pressures?

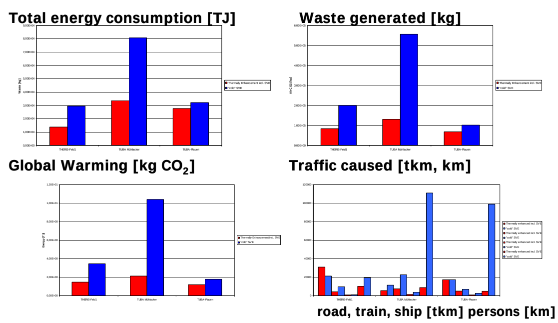
- Lisbon agenda
- Population migration
- Heterogeneity in euro-zone economies
- Skills shortage – too much unnecessary remediation & conventional remediation
- No explicit regulatory requirement
- Diversity of regulatory functions leads to fragmented consideration of sustainability dimensions
- Skills shortage

ENV.2008.3.1.2.1. Recovery of degraded soil resources

- Expected impact: According to the [EU] Thematic Strategy for Soil Protection, soil contamination is one of the main threats to which soils in the EU are confronted.
- The strategy asks Member States to ensure that contaminated sites are remediated.
- Project proposals should demonstrate to be able to achieve substantial improvement of the technologies for soil remediation in terms of sustainability (also in terms of GHG generation), persistence, and cost-effectiveness.

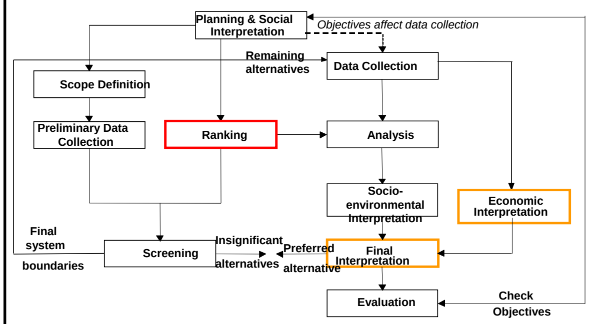
call for proposals - call closed Feb 2008; evaluation due mid-2008

CG5 – Case Studies: LCA results
Thermal enhanced / conventional (‚cold') SVE



(Dietmar MULLER, UBA Austria)
www.eurodemo.info

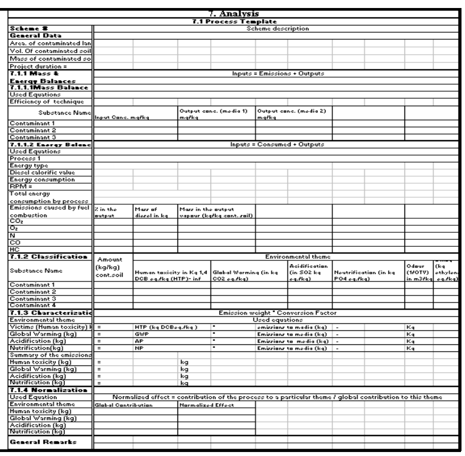
AfrS Method: LCA remediation strategy selection
Dr Abeer Shakweer



AfrS

• User Guidance

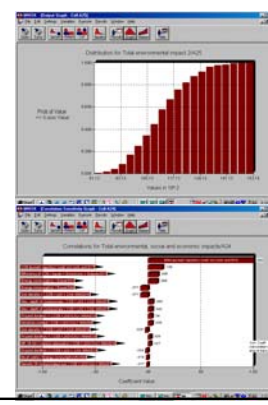
• Compatible Templates



Case Studies

- Pumpherston works site
  - Objective
  - Site description
  - Probabilistic results

Cf Shakweer and Nathanail CD Consoil 2005 / www.consoil.de



CG5 "Environmental Efficiency"
What is ECO-EFFICIENCY ?

PARTIAL MEASURE

ratio between a value (financial, ecological benefit, or social welfare) and environmental impacts (or inverse)

E/E = S / U

S ... service provided
U ... Use of environment

➔ The visions:

- **Decoupling:** same service and less environmental impacts
- **Factor 4:** double service but half the impacts

➔ How to measure S and U ?!

(Dietmar MULLER, UBA Austria)
www.eurodemo.info

sustainability appraisal tool concept

- simplification of complex individual indicators (evidence) of sustainability
- auditable back to its original evidence base
- transparent to users with widely varying backgrounds and expertise

- Dr Paul Bardos (p-bardos@r3-bardos.demon.co.uk)

&

- Professor Paul Nathanail (paul@lqm.co.uk)

Walk before you run

- stepwise approach ensures a sustainable use of resources for the sustainability appraisal process *itself*
- FIRST steps should be qualitative / semi-quantitative to avoid undue decision making costs, with quantitative approaches reserved for decisions that remain deadlocked
- identify the specific aspects (indicators) of sustainability where quantitative techniques should be applied
- make sure decision investment is well targeted

- support the engagement of multiple stakeholder viewpoints in the **initial** sustainability appraisal
- provide a stepwise platform for consensus development,
- or *if this is not possible* identify specific aspects where a quantitative approach may be needed for dispute resolution

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sustainability appraisal process components

Derivation ↑ / Visualisation ↓

- 3-d plot of the environmental, economic and social elements of sustainability overall
- Radar plots showing the derivation of economic, environmental and social indices from their headline indicators
- Radar plots (or calculations) showing the derivation each headline indicators
- Evidence Table
- Record of Decisions for Establishing the Sustainability Appraisal

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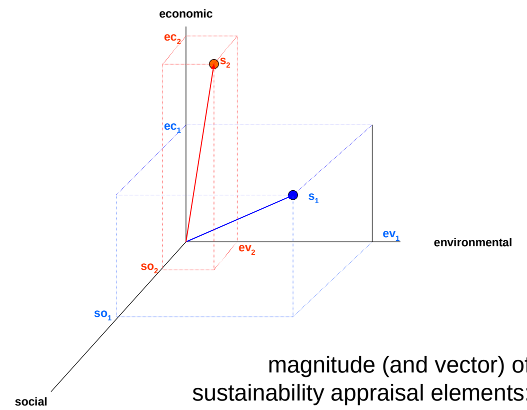

magnitude (and vector) of sustainability appraisal elements: environment, economy and society

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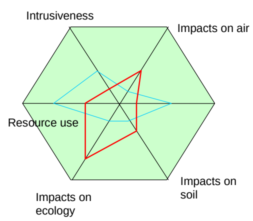
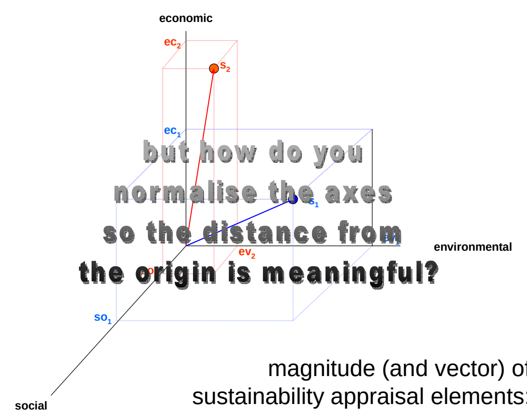
Scaling the dimensions

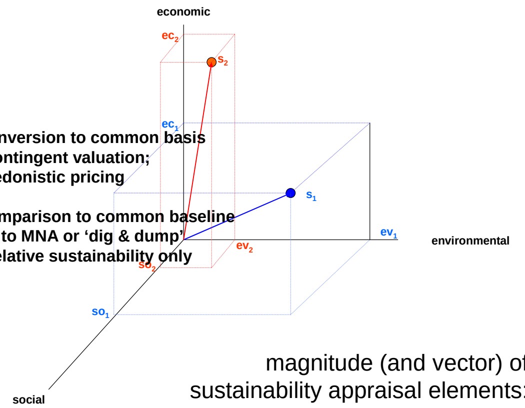
- Each “dimension” is integrated from “radar” plots (Kiviat diagrams) of “headline indicators”



Headline Indicators for the “Environment” element. The integrated value is the area bounded by the plots (blue and red)



magnitude (and vector) of sustainability appraisal elements: environment, economy and society



Conversion to common basis
•Contingent valuation;
•Hedonistic pricing

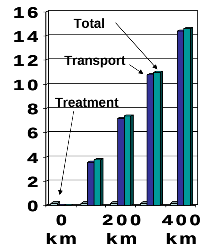
Comparison to common baseline
Eg to MNA or 'dig & dump'
•Relative sustainability only

magnitude (and vector) of sustainability appraisal elements: environment, economy and society

Closing Plato-tudes

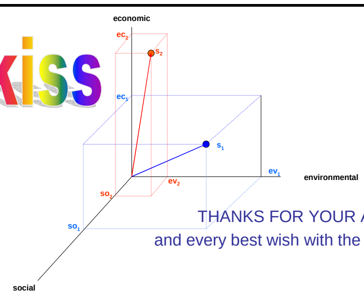
- If you 'carry on' doing what you did you will carry on getting what you got.
- Think before we act – risk assess before we remediate
- At least avoid the obviously unsustainable
- If not now – when? If not us, who?

Ex situ bioremediation Energy consumption (TJ)



(Schrenk, V., 2005; cited by Muller, D.)

kiss



THANKS FOR YOUR ATTENTION –
and every best wish with the rest of your agenda!

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paul@lqm.co.uk

Attachment 5
White Paper Chapter Facilitators and Volunteers

White Paper Chapter Facilitators and Volunteers

Chapter Title	Facilitator	Volunteers
Description and Current Status of Sustainability in Remediation	Dick Raymond, TerraSystems	Carol Dona, Corps of Engineers Lowell Kessel, GEO Phil McKalips, Environmental Standards Chuck Newell, GSI Environmental Ray Vaske, URS
Sustainability Concepts and Practices in Remediation	Stephanie Fiorenza, BP	Pierre Beaudry, Golder Associates Bob Boughton, California DTSC Dora Chiang, EarthTech Catalina Espino Guerrero, Chevron David Hull, LFR Stella Karnis, Canadian National Steve Koenigsberg, WSP Environmental Strategies Nick Lagos, Lagos George Leyva, California Region II Water Board Tiffany Swann, GSI Environmental Dave Woodward, EarthTech
A Vision for Sustainability	Paul Favara, CH2MHill	Louis Bull, Waste Management Elisabeth Hawley, Malcolm Pirnie Mike Kavanaugh, Malcolm Pirnie Maryline Laugier, Malcolm Pirnie Gary Maier, EarthTech Maile Smith, Northgate Environmental
The Impediments and Barriers	David Major, Geosyntec	John Englert, K&L Gates Mike Houlihan, Geosyntec Bill Hyatt, K&L Gates Charlie So, Shaw Environmental & Infrastructure Curt Stanley, Shell Global Solutions Elizabeth Wells, San Francisco Water Board
Vignettes of Success	Brandt Butler, URS	Jeff Caputi, Brown and Caldwell Amanda Dellens, EarthTech Maile Smith, Northgate Environmental (Other SuRF members ad hoc)

Attachment 6
Panel Members for Sustainability Exercise

Panel Members for Sustainability Exercise

Technology	Members
Pump and Treat	Brandt Butler, URS Dave Curnock, United Technologies Dave Ellis, DuPont Ben Foster, LFR Chuck Newell, GSI Environmental Dave Woodward, EarthTech
In Situ Thermal Treatment	Pierre Beaudry, Golder Associates Mike Houlihan, Geosyntec Stella Karnis, Canadian National Tiffany Swann, GSI Environmental
Accelerated Reductive Dechlorination	Susan Block, South Carolina Dept. of Health and Environmental Control Jeff Caputi, Brown and Caldwell Dora Chiang, EarthTech Amanda Dellens, EarthTech Paul Favara, CH2MHill
Excavation	Maryline Laugier, Malcolm Pirnie Nick Lagos, Lagos Lowell Kessel, GEO Paul Hadley, California Dept. of Toxic Substances and Control Dick Raymond, TerraSystems Carol Dona, U.S. Army Corps of Engineers