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What is Sustainable Remediation? Answers from the Recent North American and European Literature

Ken Lyon

RemTech 2011, October 21, Banff, AB





CONTENTS

1. REMTECH THEN AND NOW
2. WHAT'S HAPPENED IN THE MEANTIME?
3. WHAT IS SUSTAINABLE REMEDIATION?
4. HOW DO I DO GSR?
5. CONCLUDING THOUGHTS & NEXT STEPS
6. REFERENCES AND ADDITIONAL RESOURCES



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1. REMTECH THEN AND NOW – REMTECH THEN

Sustainability studies of commonly used remediation technologies in Alberta

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Sustainable Remediation in Canada Workshop

- ▶ Dave Woodward, SURF the Globe
- ▶ Robert Noel de Tilly, Green vs Sustainable
- ▶ Sebastien Yelle, Sustainability Decision Support Tool for Remediation in Canada
- ▶ Alexis Troschinetz, BalancE3 Tool
- ▶ Mike Melross, Integrating Sustainability for Contaminated Sites in the City of Edmonton
- ▶ Stella Karniss, SURF USA Framework
- ▶ Justin Kelley, SURF Canada Update



Conference Presentations

- ▶ Dave Woodward, Green vs Sustainable Remediation and Its Evolution around the World
- ▶ Justin Kelley, The Varied Landscape of Tools for Green and Sustainable Remediation
- ▶ Francois Beaudoin, GoldSET©CN-SR: An Innovative Sustainable Decision Support Tool Adapted to CN's Needs
- ▶ Anju Wicke, Green Remediation and Contaminated Sites Risk Management Best Practices: A Framework for Evaluating Sustainable Remedial Options
- ▶ Dennis Sanscartier, Life Cycle Assessment of Remediation Approaches for a Remote Diesel-Contaminated Site in Labrador
- ▶ Ken Lyon, What is Sustainable Remediation? Answers from Recent North American and European Literature

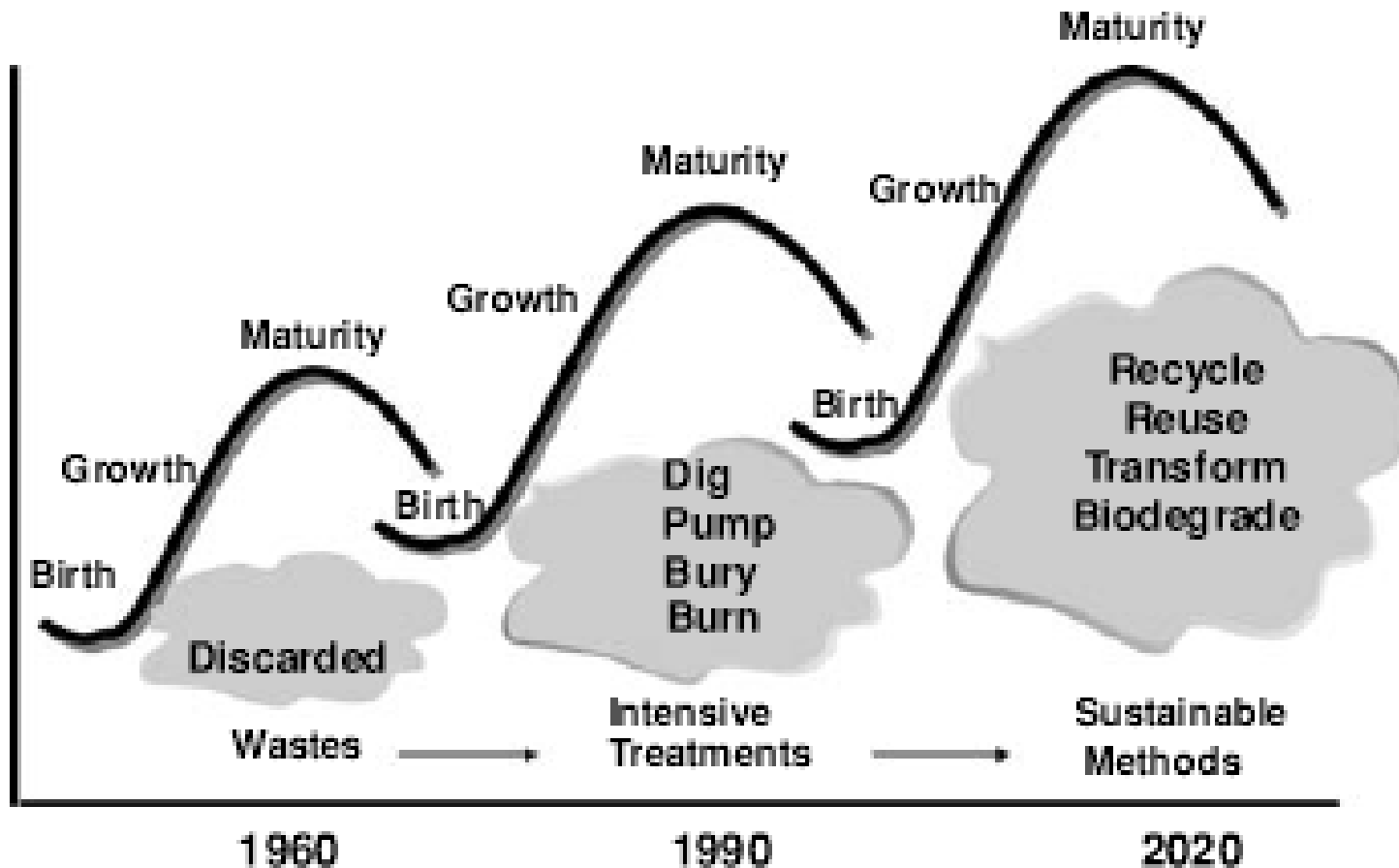


2. WHAT'S HAPPENED IN THE MEANTIME?

- ▶ 2006 - SURF-USA
- ▶ 2007 - SuRF-UK
- ▶ 2008 - USEPA Green Remediation website
- ▶ 2009 - SuRF-USA White Paper, ASTM GSR Subcommittee, SuRF-Australia
- ▶ 2010 – SuRF-Brazil
- ▶ 2011 – SuRF-UK Framework (Bardos et al.), ITRC State of Science and Practice, SURF-USA Framework & related, SuRF-Canada
- ▶ See Woodward (2011) and Noel de Tilly (2011) for overviews



EVOLUTION OF APPROACHES



Ellis & Hadley (2009) Sustainable Remediation White Paper



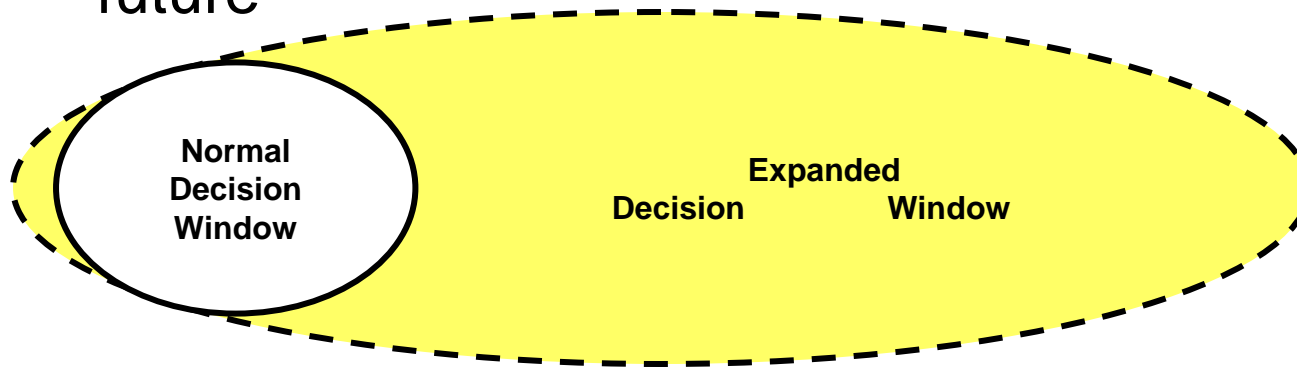
WHAT'S DRIVING THE EVOLUTION?

- ▶ Recognition of finite energy and resource use/availability
- ▶ Climate change, GHG emissions
- ▶ Contamination in “built” environment, mega-contaminated sites, environmental justice (E.g. USEPA Environmental Justice 2014 Plan)
- ▶ Corporate social licences/policies (E.g. impacts and potential impacts of Deepwater Horizon release, Enbridge Michigan and Northern Gateway pipelines, TCPL Keystone pipeline)
- ▶ **Full cost accounting** (Manning 2010)
- ▶ **Ethical investing**
- ▶ **Modelling of future cost increases**



FUTURE COST MODELLING

Move the perspective (decision window) out to the future



Now

20 Years

50 Years



\$25/T

\$100/T?

\$85/T?

Cost of CO₂ emissions

\$0.10/m³

\$ 1.00/m³?

\$5/m³?

Cost of Water

\$0.08/kWh

\$ 0.50/kWh ?

\$1/kWh?

Cost of Energy

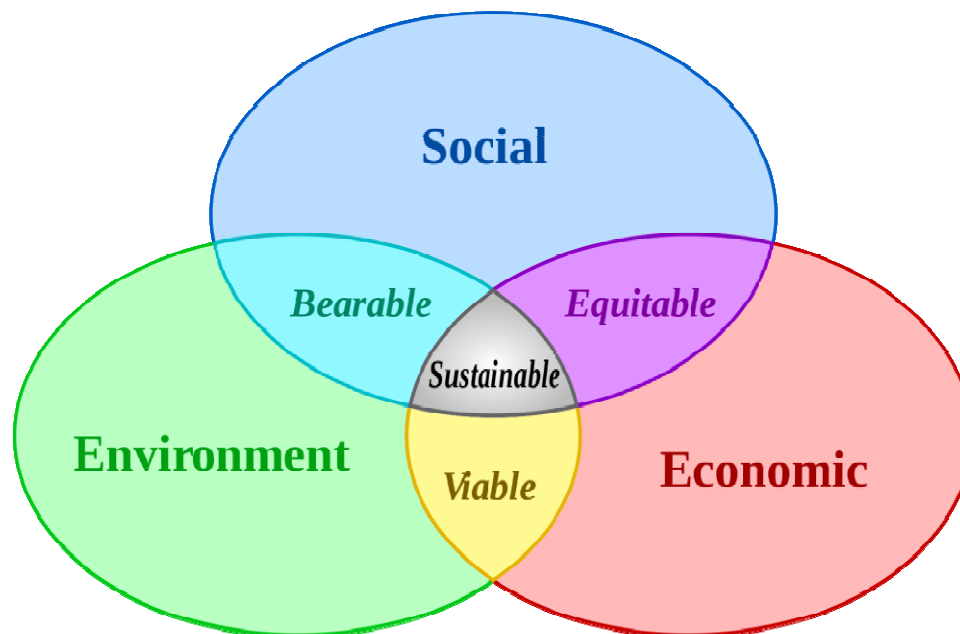
Cost of Things Difficult to Cost

Courtesy of WorleyParsons



3. WHAT IS SUSTAINABLE REMEDIATION?

- ▶ Systematic consideration to the three dimensions of sustainability (social, economic and environmental), in decision-making about rehabilitation of and management of contaminated (SuRF Canada Mission Statement 2011)



Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.

(Brundtland Commission 1987)

J. Dreo (2006) Wikimedia Commons



WHAT IS GREEN REMEDIATION? – SURF USA

- ▶ Provides net benefit on human health and the environment maximized through judicious use of limited resources (Ellis & Hadley 2009)
 - Minimize consumption of energy & natural resources
 - Reduce environmental releases, especially to air
 - Harness or mimic natural processes (e.g. MNA)
 - Reuse or recycle land or materials
 - Encourage technologies that permanently destroy contaminants
- ▶ Doesn't consider social impacts, not a TBL approach

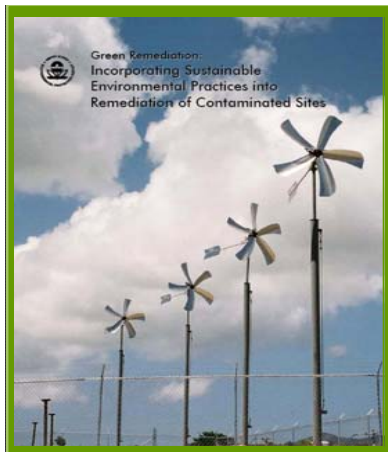


More Information from U.S. EPA



www.clu-in.org/greenremediation

- BMP Fact Sheets
- Policy References
- Technical Bulletins
- Case Studies
- Training Information
- Internet Resources



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	☀️	☁️	♻️

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response (OSWER) EPA 611-A-1-0008 August 2010

Green Remediation Best Management Practices: Clean Fuel & Emission Technologies for Site Cleanup

Office of Superfund Remediation and Technology Innovation

The U.S. Environmental Protection Agency (EPA) recognizes that Clean Fuel and Emission Technologies for Site Cleanup are an important part of the remediation process. This document provides information on the use of clean fuel and emission technologies to reduce emissions of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and particulate matter (PM) resulting from cleanup activities. The use of clean fuel and emission technologies can help reduce emissions and improve the health and safety of workers and the community. This document provides information on the use of clean fuel and emission technologies to reduce emissions of VOCs, HAPs, and PM resulting from cleanup activities. The use of clean fuel and emission technologies can help reduce emissions and improve the health and safety of workers and the community. This document provides information on the use of clean fuel and emission technologies to reduce emissions of VOCs, HAPs, and PM resulting from cleanup activities. The use of clean fuel and emission technologies can help reduce emissions and improve the health and safety of workers and the community.

Overview

Cleanup of hazardous waste sites can involve significant consumption of gasoline, diesel, or other fuels by mobile and stationary sources. Minimizing emissions of air pollutants such as greenhouse gases (GHGs) and particulate matter (PM) resulting from cleanup activities, including those resulting from the use of fuel, is a new element of green remediation strategies. Efforts to reduce these emissions during the investigation, remedial or corrective actions, and long-term operation and maintenance (O&M) must meet Clean Air Act (CAA) requirements and state or local standards as well as requirements of federal and state cleanup programs.

Development of green remediation sites can help reduce negative impacts of cleanup activities on public health and the environment. The CAA currently controls nitrogen dioxide (NO₂), ozone, lead, carbon monoxide (CO), sulfur dioxide (SO₂), and PM in the nation's ambient air pollution. EPA's air quality criteria and national ambient air quality standards (NAAQS) for ozone pollutants must be met in all state implementation plans.

The agency has issued permits of air lay GHGs in the atmosphere from diesel (CO₂), methane, chloroacetylene (CH₂Cl₂), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Other listed air emissions of these GHGs from new motor vehicles and new motor vehicle engines contribute to GHG pollution threatening public health and welfare.

Health Effects

- Respiratory problems such as cough or breathing difficulty
- Decreased lung function and increased susceptibility to respiratory infections
- Aggravated asthma and chronic bronchitis
- Compromise and heart attack

Environmental Effects

- Increased smog (and reduced visibility) primarily due to increased ground-level ozone that oxidizes other pollutants, gases such as CO₂
- Acidification of lakes and streams
- Human exposures to ozone and fine particulate matter
- Climate degradation and increased degradation of soil
- Changes to weather, water and soil levels
- Decreased populations and diversity of fish and other aquatic animals and plants
- Extension of these land remediation materials or structures

Opportunities for reducing emissions of air pollutants from internal combustion engines in vehicles and stationary sources used during cleanup activities and implementation include maximizing use of:

- Best-in-class equipment and maintenance to improve efficiency of vehicles and field equipment (page 1)
- Alternative fuels and fuel additives (page 4), and
- Fuel-efficient and alternative vehicles (page 8).

Operations and Maintenance

Strategies for reducing unneeded engine use and fuel consumption (and associated air emissions) on a routine basis can be incorporated into the management plans, transportation plans, personnel documents, for cleanup services or products, and internal training programs. The strategies focus on engine size reduction, pre-walk maintenance to ensure peak operating efficiency, changes in daily routines, and vehicle fleet management.

or: www.epa.gov/superfund/greenremediation



4. HOW DO I DO GSR?

- ▶ Consider and select a process framework
 - SuRF-UK and Australia, SURF-USA (2011)
 - SuRF-Canada coming 2012/2013
- ▶ Consider and select indicator metrics
- ▶ Take a phased/tiered approach and consider and select tool(s)
- ▶ Look at some case studies



Six Steps

- ▶ Identifying need (and context)
- ▶ Identifying stakeholders to involve
- ▶ Agreeing on objectives for the assessment
- ▶ Agreeing on scope
- ▶ Agreeing on approach
- ▶ Execution



GSR INDICATORS & METRICS – ENVIRONMENTAL (GREEN REMEDiation)

- ▶ Main Indicators
 - Air including GHG emissions
 - Water including consumption
 - Resource use and waste
 - Energy use and source
 - Others – soil, ecology
- ▶ Consider direct and indirect project impacts
- ▶ Case Study – Wicke (2011) looked at GHG emissions, water consumption, waste generation & impact on enviro media



GSR INDICATORS & METRICS – ECONOMIC AND SOCIAL

Economic Metrics

- ▶ Direct capital and operating costs of project
- ▶ Indirect costs and benefits (see Environmental & Social)

Examples of Social Metrics

- ▶ Health & Safety
- ▶ Infrastructure Wear-and-Tear
- ▶ Employment, Fit with Community Policy & Planning, Other Indirect Economic Spinoffs
- ▶ Environmental Justice
- ▶ Property Value



GSR TIERS AND TOOLS

(Holland et al. 2011)

▶ Tier 1

- Checklists, lookup tables, guidelines, matrices

▶ Tier 2

- Spreadsheet scoring and weighting systems (multiple criteria analysis)

- Quantitative air emission, water and energy calculations

- RemTech 2011 Examples - GoldSET© (Beaudoin 2011) for all CN site work, GR Evaluation Framework for PWGSC (Wicke 2011), BalancE3 Tool (Traschinetz 2011)



- ▶ Tier 2 cont'd
- ▶ - See Kelley (2011) for overview, expects number of tools to double from about 20 in next several months
- ▶ Tier 3
 - Life cycle analysis, return on investment and other detailed financial analyses
 - Examples – WorleyParsons EcoNomics™ (see Hardisty 2010 for early case studies)



5. Concluding Thoughts and Next Steps

- ▶ Green and sustainable remediation gaining tremendous momentum
- ▶ USA and UK/Australia approaches in place, Canada in development
- ▶ Several tools available or coming soon ... which are best?
- ▶ Don't need spreadsheet tools to start thinking about it
- ▶ Need more case studies, more standardized indicators & metrics especially for social impacts
- ▶ Need to assure regulator that won't compromise intent of adverse effect management frameworks
- ▶ Need to assure site owners/operators that can allow site closure



6. References & Additional Resources

- Bardos, P., B. Bone, R. Boyle, D. Ellis, F. Evans, N.D. Harries, and J.W.N. Smith, 2011. Applying Sustainable Development Principles to Contaminated Land Management Using the SuRF-UK Framework. *Remediation Journal*, 21(2), pp.77-100.
- Defra, Feb 2011. Contaminated Land Remediation. CL:AIRE, London, England. 120 p.
http://www.claire.co.uk/index.php?option=com_phocadownload&view=file&id=207:External-Documents&Itemid=61
- Ellis, D.E., and P.W. Hadley (Eds.), 2009. Sustainable Remediation White Paper – Integrating Sustainable Principles, Practices, and Metrics into Remediation Projects. *Remediation*, Summer 2009, pp. 5-114. <http://www.sustainableremediation.org/library/issue-papers/>
- Hardisty, P.E., 2010. Environmental and Economic Sustainability. CRC Press, New York, NY. 315 p.
- Holland, K.S., et al., 2011. Framework for Integrating Sustainability into Remediation Projects. *Remediation Journal*, Spring 2011, pp.7-38. www.sustainableremediation.org.



Interstate Technology Research Council, May 2011. Green and Sustainable Remediation: State of the Science and Practice. <http://www.itrcweb.org/guidancedocument.asp?TID=77>

Manning, P., 25 Jan 2010. Canada and the Environment: A fresh start for a fresh decade. The Globe and Mail, Toronto, ON. <http://www.manningcentre.ca/blog/canada-and-environment-fresh-start-fresh-decade>

Pachon, C., 15 Mar 2011. Introductions. In USEPA CLU-IN Seminar, US and EU Perspectives on Green and Sustainable Remediation Part 2. www.cluin.org

Sustainable Remediation Forum Canada (SuRF Canada) www.surfcanada.org

Sustainable Remediation Forum UK (SuRF UK). www.claire.co.uk

Sustainable Remediation Forum USA (SURF), www.sustainableremediation.org.



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References & Additional Resources

US Environmental Protection Agency websites.

www.clu-in.org/greenremediation/,

www.epa.gov/superfund/greenremediation/

World Commission on Environment and Development,
Apr 1987. Our Common Future. Oxford University
Press, 416 p.

See slides 3, 4 and 5 for RemTech 2011 references.