EURODEMO

European Co-ordination Action for Demonstration of Efficient Soil and Groundwater Remediation

What do we mean by ECO-EFFICIENCY?

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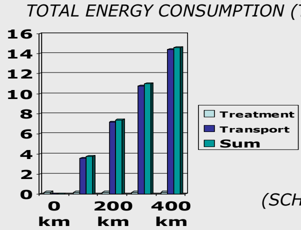
Varmöte 2007, Örebro, March 20 – 21, 2007

BIOLOGICAL SOIL TREATMENT
An enviromentally friendly technology?

Ex-situ biological treatment (10.000 t soil)

TOTAL ENERGY CONSUMPTION (TJ)



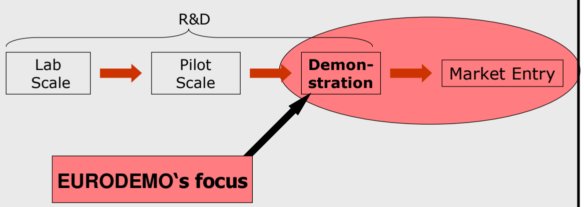
(SCHRENK, V., 2005)

OUTLINE OF THE PRESENTATION

- ***EURODEMO***
- Eco-Efficiency
  - General Background
  - Land Remediation
- Framework / Indicators
- Case Studies
- Model Protocol (Tiered Approach)

EURODEMO

European co-ordination action for demonstration of soil and groundwater remediation technologies



EURODEMO

Aims

- to accelerate **acceptance** of and
- to accelerate **market confidence** in

innovative soil and groundwater remediation technologies through **comprehensive information** on demonstration projects in Europe.

"If you always do what you did, you will always get what you got"

CG5 "Environmental Efficiency" OBJECTIVES

Framework Environmental Efficiency Criteria

→ *defining common criteria to assess environmental effects*

→ *structuring the assessment process to facilitate the comparability of environmental effects*

- providing analytical tools for the assessment
- producing protocols to control sustainability

→ to support the decision process and the selection of remediation approaches at an early stage

→ to strengthen the competitiveness of 'new' technologies'

CG5 "Environmental Efficiency"

6th Environment Action Programme

Priority area: 'Sustainable Use of Natural Resources and Management of Waste'

- To ensure that the consumption of renewable and non-renewable resources does not exceed the carrying capacity of the environment,
- To achieve a de-coupling of resource use from economic growth through significantly improved resource efficiency, dematerialisation of economy, and waste prevention,
- To decouple the generation of waste from economic growth and achieve a significant overall reduction in the volumes of waste generated through improved waste prevention initiatives, better resource efficiency, and a shift to more sustainable consumption patterns.

6th Environmental Action Plan Follow Up Initiatives (2005)

Environmental Technology Action Plan

- Technologies to be verified in European System
- Eco-efficient, evaluated against 'indicators'
- Globally competitive
- Supported financially (risk funding) by the EU and MS

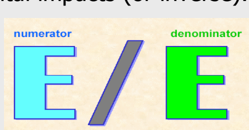
Thematic Strategy on the Sustainable Use of Natural Resources'

- Decoupling use of resources from economic growth
- Life cycle thinking integrated to sector policies

CG5 "Environmental Efficiency"

What is ECO-EFFICIENCY ?

E/E is defined as the ratio between value (financial, cost, price, wealth, or social welfare) and environmental impacts (or inverse).



Do we need and how to get "a (single) score" for the denominator of eco-efficiency by adding up multiple components of environmental pressures/impacts ?

CG5 "Environmental Efficiency"
What is ECO-EFFICIENCY ?

E-E = S / U

S … service provided
U … Use of environment

➔ The visions:

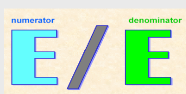
- **Decoupling:** same service and less environmental effects
- **Factor 4:** double service but half the impacts

➔How to measure S and U ?!

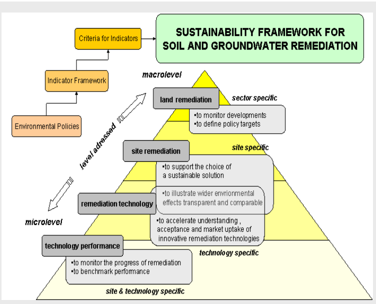
CG5 "Environmental Efficiency"
FRAMEWORK ECO-EFFICIENCY

DESIGNED TO
illustrate E/E by variable ratios between value (financial, cost, price, wealth, or social welfare) and environmental impacts

➔ control easy and effective
➔ be applied across different levels
➔ use easily available data
➔ communicate to involved stakeholders



Indicators for Environmental Improvements / Effects ?



Benefits (general)
Rehabilitated area (m^2)
Mass of treated contaminants (t)
Mass of treated soil (t)

Wider Impacts (1st proposal 2005)

- Energy consumption (kWh)
- Waste generation (t)
- CO2-emissions (t)
- Traffic ? (t x km)

CG5 "Environmental Efficiency"
Case studies – Technology Selection

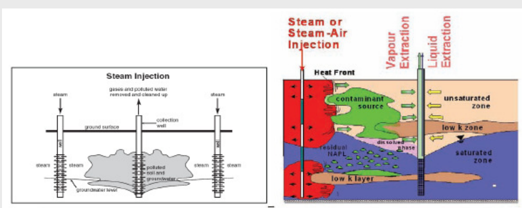
- technologies described by CG 6
- literature survey

  → Thermal enhanced remediation (SVE) of volatile contaminants (CHC, BTEX)

  → PRB (filter material: activated carbon)

VEGAS

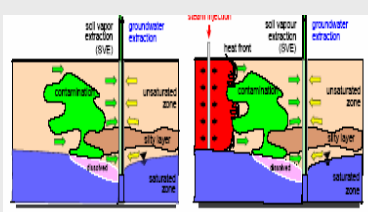
Remediation Technologies
In-situ Thermal Treatment



- **Steam Enhanced Extraction (SEE – see figures, KOSCHITZKY, 2003)**
- **Electrical Resistive Heating (ERH)**
- **Thermal Conductive Heating (TCE)**

CG5 "Environmental Efficiency" – Case Studies
In-situ thermal remediation (TUBA, THERIS)

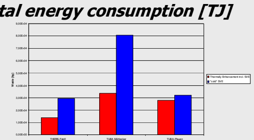
VEGAS



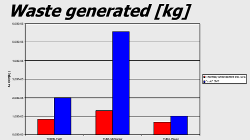
Conventional	SVE (cold)	sand, gravel
Thermal	TUBA (Steam-Air-Injection)	sand, gravel
	THERIS (Thermal Wells)	clay, silt

CG5 – Case Studies: LCA results (2)
Thermal enhanced / conventional (‚cold‘) SVE

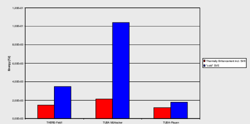
Total energy consumption [TJ]



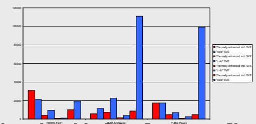
Waste generated [kg]



Global Warming [kg CO_2]



Traffic caused [tkm, km]



road, train, ship [tkm] persons [km]

Thermal enhanced vs. conventional (‚cold‘) SVE
TIME, COSTS & ENERGY USED

Project	**Field 1**	**Mühlacker**	**Plauen**
Method	THERIS	TUBA	TUBA
time	90 days (>> 3 years)	15 month (> 10 years)	110 days (> 8 years)
cost savings	75 %	34 %	56 %
energy savings	58 %	59 %	55 %

CG5 – Enhanced Thermal in-situ remediation
Case study SUMMARY (1)

- Clear indication that environmental impacts caused by the application of a thermally enhanced remediation are significantly (factor > 2) less than by a conventional, ‘cold’ soil vapour extraction
- Clear indication that costs for a thermally enhanced in-situ remediation are less or at least equal to a cold SVE
- **GOVERNING FACTOR** for environmental impacts and costs caused by in-situ remediations is **TIME**
- Whereas a ‘cold’ SVE generally tends to be a long-term operation, thermally enhanced remediation can provide short-time solutions for CHC (or BTEX) contaminated sites

CG5 – Enhanced Thermal in-situ remediation
Case study SUMMARY (2)

EURODEMO:

Enhanced Thermal in-situ remediation of volatile contaminants

- **is an eco-efficient innovation,**
- **which is also likely to save time and money significantly.**

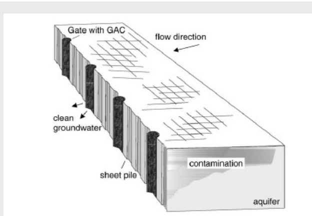
"FACTOR-4-technology" !!!!

Remediation Technologies
Permeable Reactive Barriers

Belfast 1994: The 1st European zero-valent Iron PRB

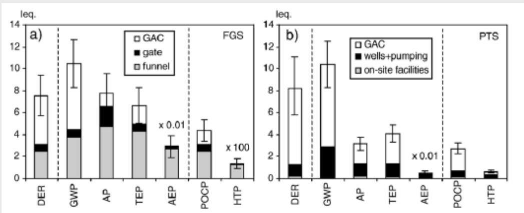
[Jeffries, 2005]

CG5 "Environmental Efficiency" – Case Studies
Permeable Reactive Barrier



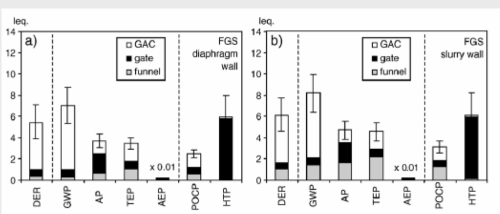
Conventional	pump & treat	GAC
Innovative	permeable reactive barrier	GAC

CG5 – Case studies: LCA results (1)
PRB / Pump & Treat



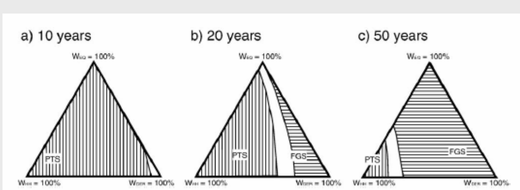
PRB (sheet pile) vs. P&T: Impacts normalized and expressed as inhabitant equivalents

CG5 – Case studies: LCA results (2)
PRB – alternative scenarios



PRB (slurry wall) vs. PRB (diaphragm wall): Impacts normalized and expressed as inhabitant equivalents

CG5 – Case studies: LCA results (3)
PRB vs. P&T – consequences of operation times



PRB (FGS) vs. P & T (PTS): Weighting triangles comparing

- impacts on ecological quality
- depletion of resources (energy)
- Impacts on human health

CG5 – Permeable reactive barrier
Case study SUMMARY (1)

- maintenance of the treatment unit/material (use and replacement of GAC) is the major driver to most of the impact categories
- at short operation periods (< 10 to 15 years) environmental impacts caused by PRB's exceed those of a conventional pump & treat system
- ***EURODEMO*** *impact categories do not show significant differences (factor > 2), of environmental impacts, neither in between different PRB scenarios nor against a conventional P&T system*
- *The chosen further 5 impact categories do not show significant differences either*

CG5 – Permeable reactive barrier
Preliminary Case study SUMMARY (2)

EURODEMO

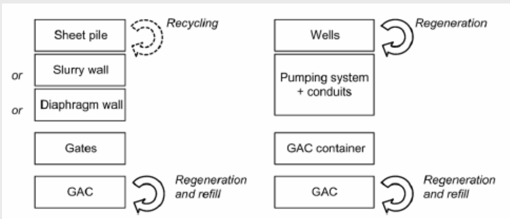
Permeable reactive barriers (GAC)

- **may gain eco-efficiency at long operation times,**
- **regarding environmental impacts the choice of implemented technologies**
  - **for the vertical walls of the funnel and**
  - **treatment of contaminated groundwater**
- **is of crucial importance.**

Assessing wider environmental effects
Land Remediation: A Tiered LCA based Approach

	data quality and data analysis + overview ++ selective +++ comprehensive			
	Key Elements & Processes	***Impact Categories***	***Impact Parameters***	***Assessment***
Tier 1: Qualification	+	+++	-	qualitative
Tier 2: Simplified LCA	++	+	+	quantitative
Tier 3: LCA	+++	+++	+++	quantitative

Identification of Key Elements & Processes
PRB / Pump & Treat



Key elements of PRB (different scenarios) and P&T

QUALIFICATION (Tier 1 Assessment)
List of Environmental Impact Categories

INPUTS	energy consumption	SECONDARY IMPACTS	global warming
	use of minerals		acidification
	land use		photochem. smog
	water consumption		ozone depletion
OUTPUTS	Waste generation		eutrophication
	emissions to air		human toxicity
	emissions to surface water		aquatic toxicity
			terrestrial toxicity

QUALIFICATION (Tier 1 Assessment)

Qualification Phase: results to displayed by

- **a summarising table providing an overview** on all remedial options under consideration and the classification of the qualified environmental impact categories,
- **figures introducing the key elements of each remedial option**,
- tables or figures explaining the processes involved to the different key elements of a remedial option and giving an **indication on processes which are qualified as causing significant environmental impacts.**

SIMPLIFIED ANALYSIS (Tier 2 Assessment)

SIMPLIFIED LIFE CYCLE ASSESSMENT:

Inventory Analysis and ***Impact Assessment*** are performed quantitatively but with a focus to

- those processes which have been assigned as being of major relevance (see results Tier 1 and/or according to the 5 technology groups proposed by SCHRENK 2006)
- few selected impact categories
- Cut-off Criteria: up to 20 %

SIMPLFIED ANALYSIS (Tier 2)
List of Environmental Impact Categories

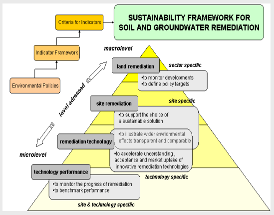
	IMPACT CATEGORIES	PARAMETERS
INPUTS	energy consumption	*renewable, non-renewable & total energy consumption*
	water consumption	*m³ water*
OUTPUTS	waste generation	*hazardous & non-hazardous waste (in tons)*
Secondary Impacts	global warming	*carbon dioxide (kg CO_2)*

SIMPLIFIED ANALYSIS (Tier 2)

Simplified Analysis: Results displayed by

- tables or figures explaining the processes involved to different key elements of a remedial option and giving an indication on processes which are qualified as causing significant environmental impacts,
- a summarising table providing an overview on all remedial options under consideration and the results of the assessment of selected environmental impacts, and
- figures (e.g. bar charts) indicating the results of the assessment normalised to the ‘reference scenario’

Sustainability framework in land remediation
Final recommendation: June 2007 (?)



Benefits (general)
Rehabilitated area (m²)
Mass of treated contaminants (t)
Mass of treated soil (t)

Wider Impacts (Tier 2: Simplified LCA)
- Energy consumption (kWh)
- Water consumption (m³)
- Waste generation (t)
- CO2-emissions (t)

Possible 'Meta'-Criteria: Project Energy Index
= total energy consumption of a remediation project normalised against a theoretical thermal treatment

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Sustainable Soil and Groundwater remediation
Future Use of Eco-efficiency Criteria (1)

PRIVATE SECTOR (technology development and vending)

Data for & implementation by
- Measuring/reporting for technology development (demonstrating innovative technologies)
- consultants, vendors and market entry of new products and services

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Sustainable Soil and Groundwater remediation
Future Use of Eco-efficiency Criteria (2)

PRIVATE & PUBLIC SECTOR (technology application)

Data for & implementation by
- decision support during the planning phase for a site remediation project,
- tendering of remediation projects and
- final reporting of remediation projects

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Sustainable Soil and Groundwater remediation
Future Use of Eco-efficiency Criteria (3)

PUBLIC SECTOR (monitoring and reviewing policy)

Data for & implementation by

- monitoring the land remediation sector for general developments (compilation, reporting and review at regional, national and European level)
- development and definition of general policy targets

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EURODEMO

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ACKNOWLEDGEMENTS:

EURODEMO is funded by the European Commission DG Research under Contract No. GOCE 003985

VAREMÖTE 2007, March 20 & 21, 2007