CL:AIRE remediation projects and the sustainable remediation initiative SuRF-UK

SAFESPUR Workshop
14th October 2010 Birmingham

Dr Rob Sweeney, CL:AIRE

CONTAMINATED LAND: APPLICATIONS IN REAL ENVIRONMENTS

1 GREAT CUMBERLAND PLACE | 7TH FLOOR | LONDON | W1H 7AL
T - 020 7258 5321 | F - 020 7258 5322 | www.claire.co.uk

CL:AIRE

Contents

Introduction to CL:AIRE

- Independent not-for-profit organisation set up by Govt and SAGTA in 1999
- Objectives include:

  - to stimulate the regeneration of contaminated land in the UK by raising awareness of, and confidence in, practical and sustainable **remediation technologies** and effective **methods for monitoring and investigating** sites.

  - to disseminate technology demonstrations and research

CL:AIRE Review Process

- Scientific validity of the application;
- Robust nature of the methodology;
- Contribution to the UK contaminated land marketplace;
- Suitable assessment of site criteria; and
- Competencies in forms of project management

Technology and Research Group

Mike Pearl – UKAEA (Chair)
Mike Summersgill – RSK Ltd (Deputy chair)
Bob Barnes – Environment Agency
Dr Brian Bone – independent
Dr John Campbell – independent
Prof Max Coleman – Caltech
Steve Edgar – Vertase FLI
Dr Theresa Kearney – Northern Ireland Environment Agency
Dr David Lerner – Uni of Sheffield
Prof Phil Morgan – The Sirius Group
Dr Mike Rivett – Uni of Birmingham
Prof Jonathan Smith – Shell Global Solutions

TDP24 Case Study

Application of thermally enhanced soil vapour extraction to remediate the unsaturated zone at the Western Storage Area, Harwell (Provectus Group and RSRL)

Background

•Until 1930s: Racehorse stables

•1935 to 1946: RAF airfield

•Nuclear R&D site for over 40 years

•Since mid-1990s, focus on decommissioning and clean up for redevelopment (“Harwell Science and Innovation Campus”)

TDP24 Case Study

Western Storage Area (WSA)

- 25 shallow pits (4-5 m) used for disposal of chlorinated solvents (approx 20 tonnes) and other chemicals
- Pits were excavated and contents removed in 2004
- Residual suite of VOCs & hydrocarbons in unsaturated zone of Chalk up to c25 mbgl

Project Objectives

- Target contaminants, reduce loading significantly & minimise emissions
- Undertake pilot trial - design & configure remediation evaluating multiple techniques
- Undertake phased remediation as NDA funding becomes available

TDP24 Case Study

Pilot Trial

- Site characterisation to gain current data on unsaturated zone contamination profile
- Test SVE technology application
- Examine:
  - –Conventional SVE
  - –Targeted depths
  - –Assistance of air/ozone sparging
  - –Thermal enhancement

Recommendations

Recommended that full-scale remediation of the unsaturated zone is undertaken within the WSA comprising:

- SVE in the vicinity of the former chemical waste disposal pits.
- Thermal enhancement of the SVE in areas of gross contamination.

TDP24 Case Study

Methodology

•Conductive heating and vacuum extraction applied simultaneously to the impacted zone

•Heater contains an electrically powered heating element with an operating temperature of 500-800°C

•Heat transfer by thermal conduction can give rise to target zone heating between 100-350°C

•Contaminants are partitioned into the vapour phase. Vapours are collected continuously using centrally located SVE

CL:AIRE

TDP24 Case Study

Results and Conclusions

Extraction Rates:

- –At start of un-enhanced trial - 3kg/day
- –During Phase 1 thermal enhancement - 17kg/day
- –End of Phase 2 enhancement - 3kg/day
- –During Phase 3 enhancement - 2kg/day
- –Following Phase 3 enhancement - 0.3kg/day

•No free product in nearby groundwater monitoring wells

•VOC and SVOC concentrations in condensate are significantly lower following TESVE

•Estimate of total mass of contaminants removed from WSA unsaturated zone was approximately 1 tonne

Final TDP24 Report is available from CL:AIRE website.

TDP13 Case Study

Passive treatment of severely contaminated colliery spoil leachate using a permeable reactive barrier

The Tyelaw Burn and Shilbottle spoil heap lie in Northumberland

One of the worst quality spoil or mine waters in the UK:
pH < 3.5; Acidity ~ 6,000 mg/L as $CaCO_3$
Fe ~ 1,100 mg/L; Mn ~ 300 mg/L; Al ~ 700 mg/L
SO_4 ~ 15,000 mg/L

Problem: Seepage of water of this quality, from a perched water table, through the pyritic spoil into Tyelaw Burn.

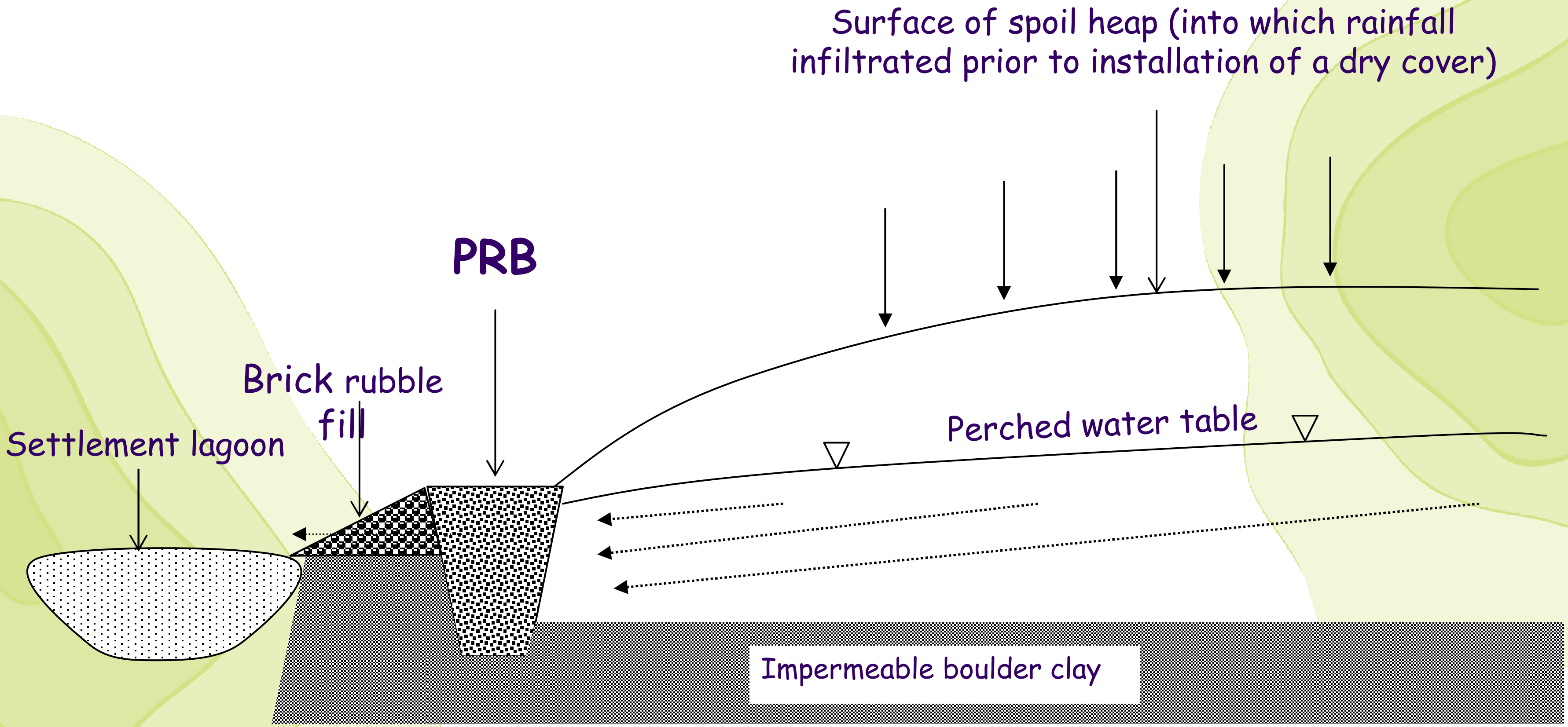
Solution: Permeable Reactive Barrier (PRB) was designed.

• a trench ~ 180 m in length by 2-3 m width and depth

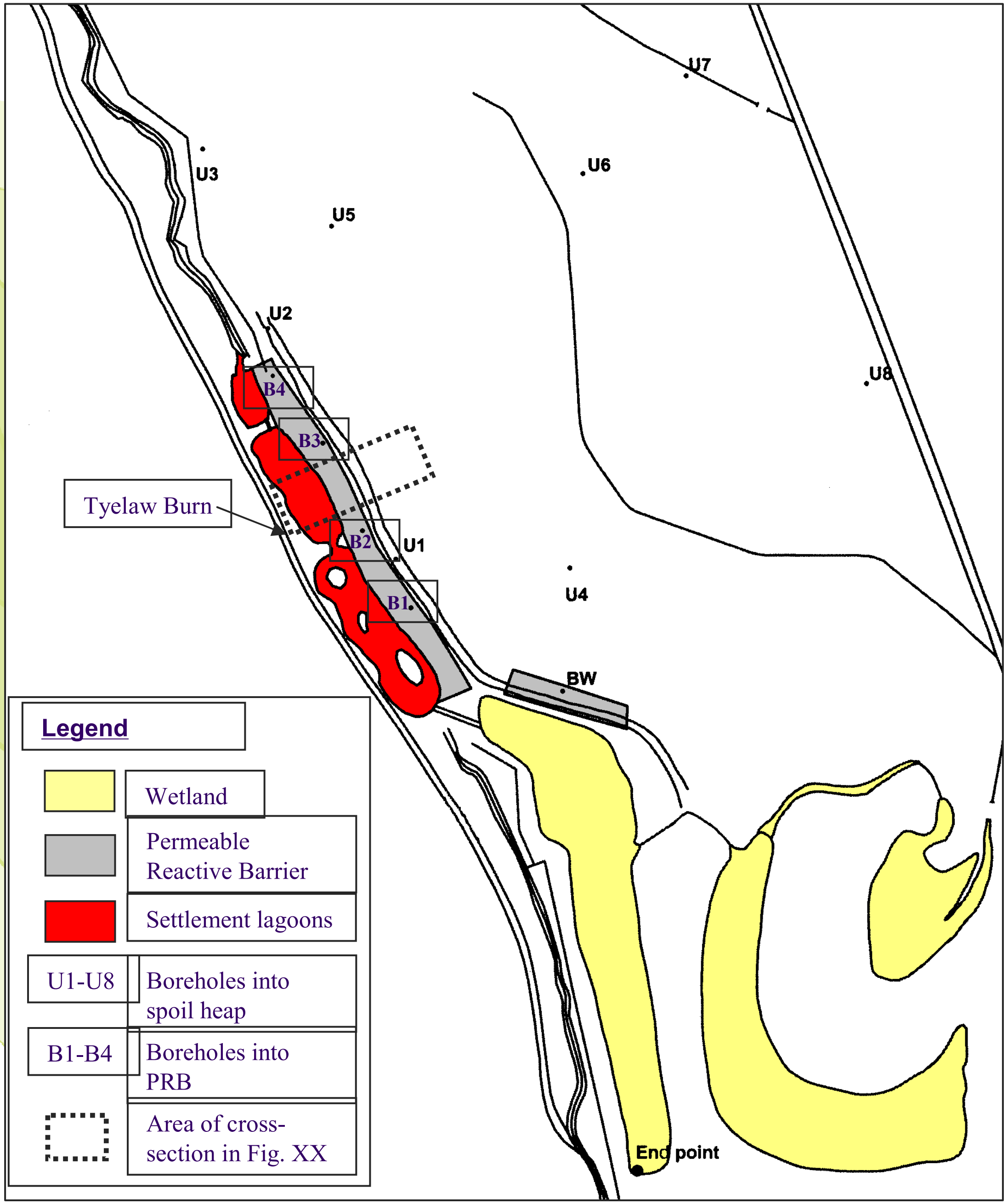
•Laboratory tests were used to identify suitable reactive media for the PRB to:

- generate alkalinity
- immobilise metals
- have an appropriate permeability

•Mixed substrate of 25% composted horse manure, 25% green waste compost, and 50% limestone gravel.



- treated leachate exits the barrier through a permeable face lined with brick rubble
- series of three settlement ponds for polishing
- enters a reedbed for a final polishing before entering the Tyelaw Burn.


U7
U6
U3
U5
U2
U8
B4
B3
Tyelaw Burn
B2
U1
U4
B1
BW
Legend
Wetland
Permeable Reactive Barrier
Settlement lagoons
U1-U8
Boreholes into spoil heap
B1-B4
Boreholes into PRB
Area of cross-section in Fig. XX
End point

CL:AIRE

Results & indicative costs

- Concentrations of both iron and aluminium were typically reduced by in excess of 90%, and acidity concentration decreased from a mean of 2,500 mg/L as $CaCO_3$ to < 500 mg/L as $CaCO_3$.

	Passive system	**Active system**
Capital expenditure – PRB and lagoons	£78,000	£200,000
Capital expenditure – wetland	£200,000	-
Operational expenditure	£7,500 / year	£44,500 /year

Active System - High Density Sludge Plant

Available as CL:AIRE TDP13 report from website

TDP25 Case Study

Decision support tool for innovative in situ multi-contaminant groundwater remediation

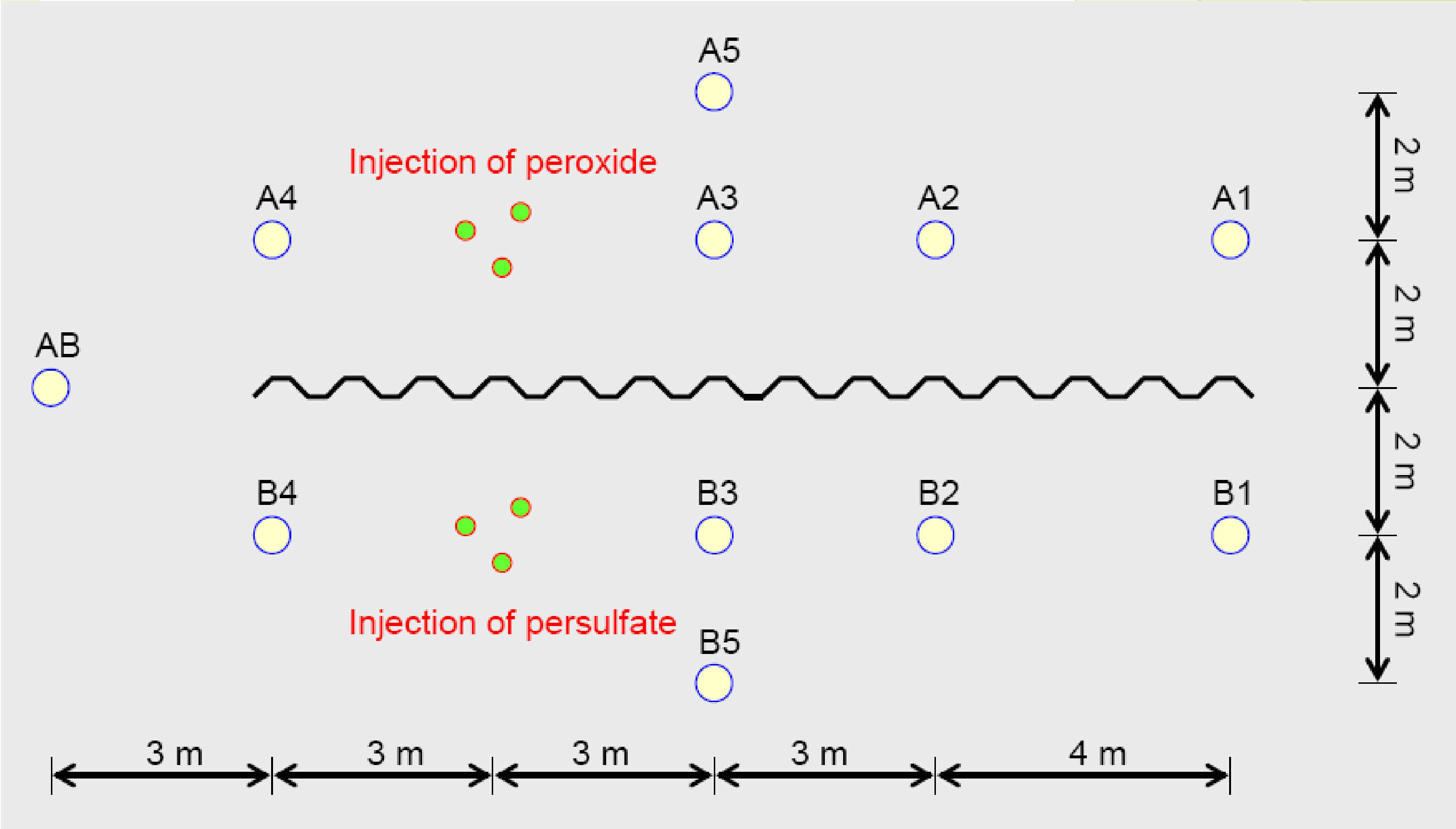
This project involved WorleyParsons, Imperial College London, National Grid Property Ltd, Environment Agency and Bradford City Council.

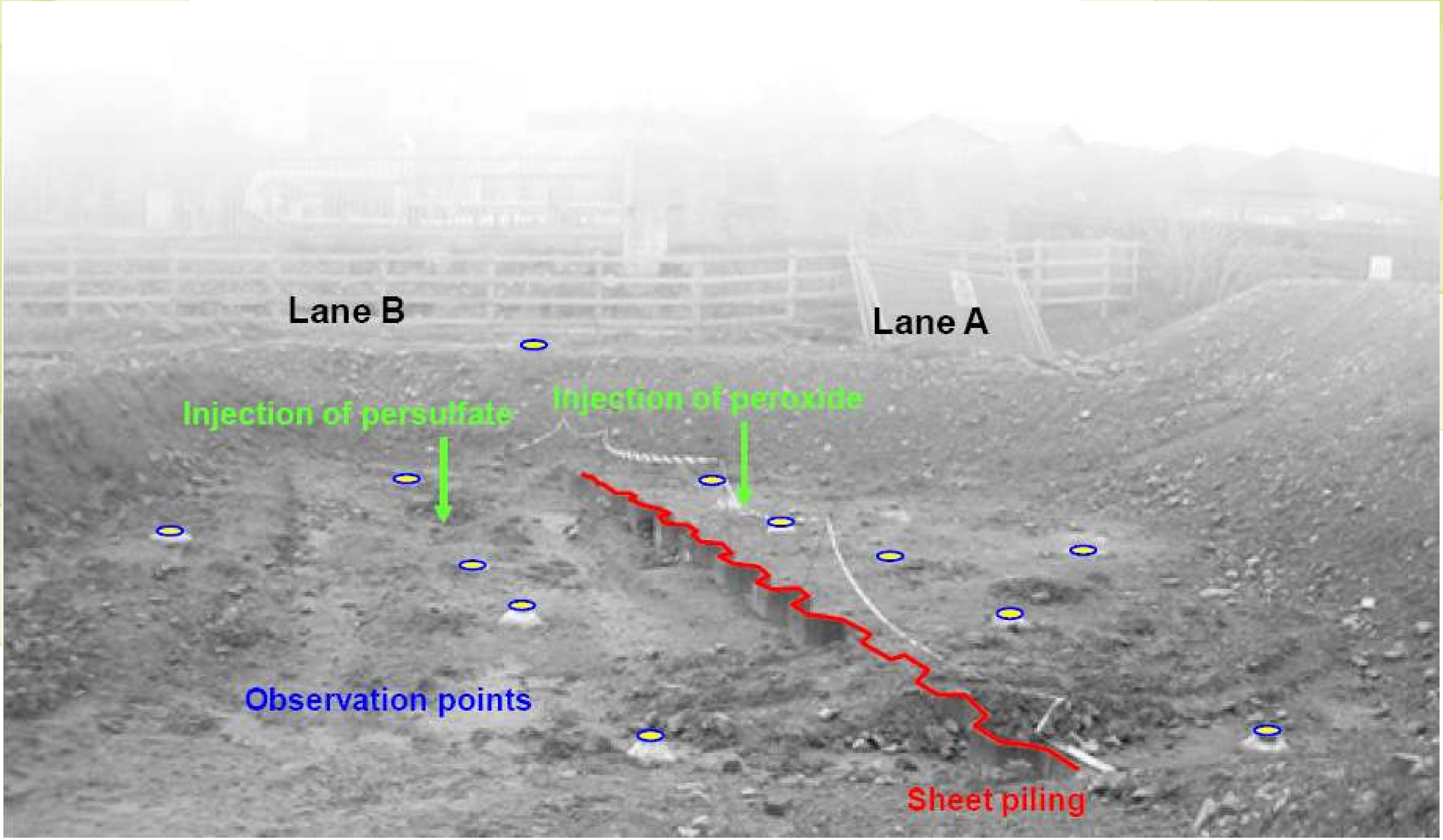
An experimental facility was constructed at a former gasworks site to provide comparative in situ technology trials.

- investigate the performance of various oxidation technologies in the field
- laboratory analyses to assess the controls on the chemical reaction rates of the oxidants used in the field trials
- provide innovative modelling tools for the interpretation of the field data
- formulate a decision support framework

Four comparative trials were undertaken:

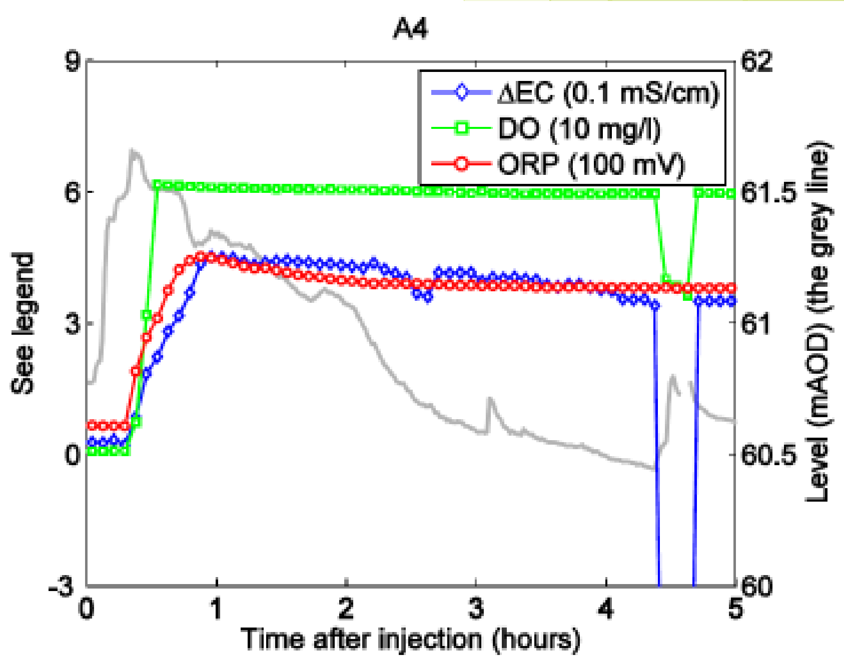
1. Catalysed hydrogen peroxide
2. Sodium persulfate trial
3. Enhanced bioremediation trial (gPRO, super-saturated oxygenated water)
4. Control




Lane B
Lane A
Injection of persulfate
Injection of peroxide
Observation points
Sheet piling

Fieldwork outcomes

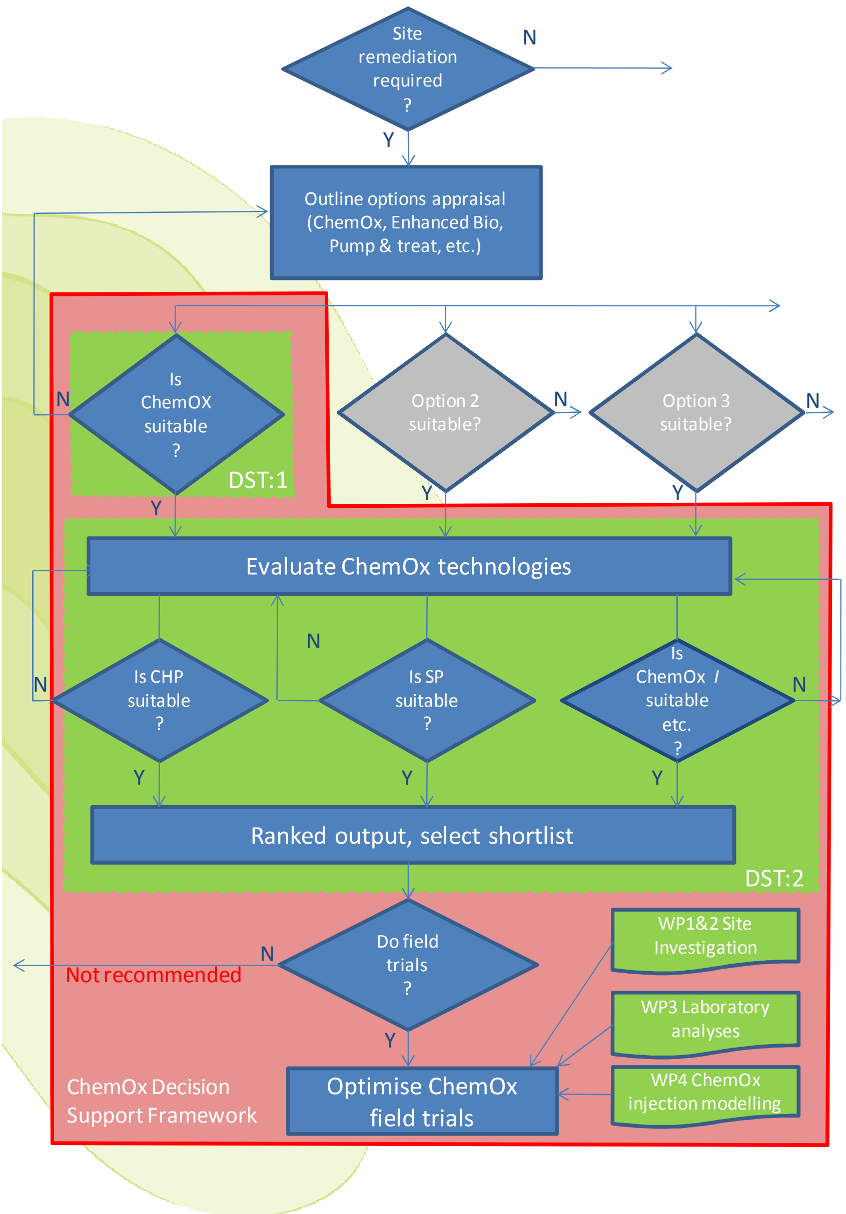
- Comparative trials of catalysed hydrogen peroxide (CHP) and sodium persulfate (SP)
- Lifespan of SP was 3 days and CHP 1 day
- Rapid breakthrough of oxidant observed (approx 30 mins for a point 3 m from injection point)
- Oxidants caused lowering of gw pH, esp. for SP trial, where pH values < 3 occurred for prolonged periods (>20 days)
- Significant increases in iron (SP and CHP), sulphate (SP), sodium (SP), copper (SP) and nickel (SP) concentrations were detected
- gPro trials showed that optimum conditions for aerobic degradation were not achieved due to excess oxygen demand

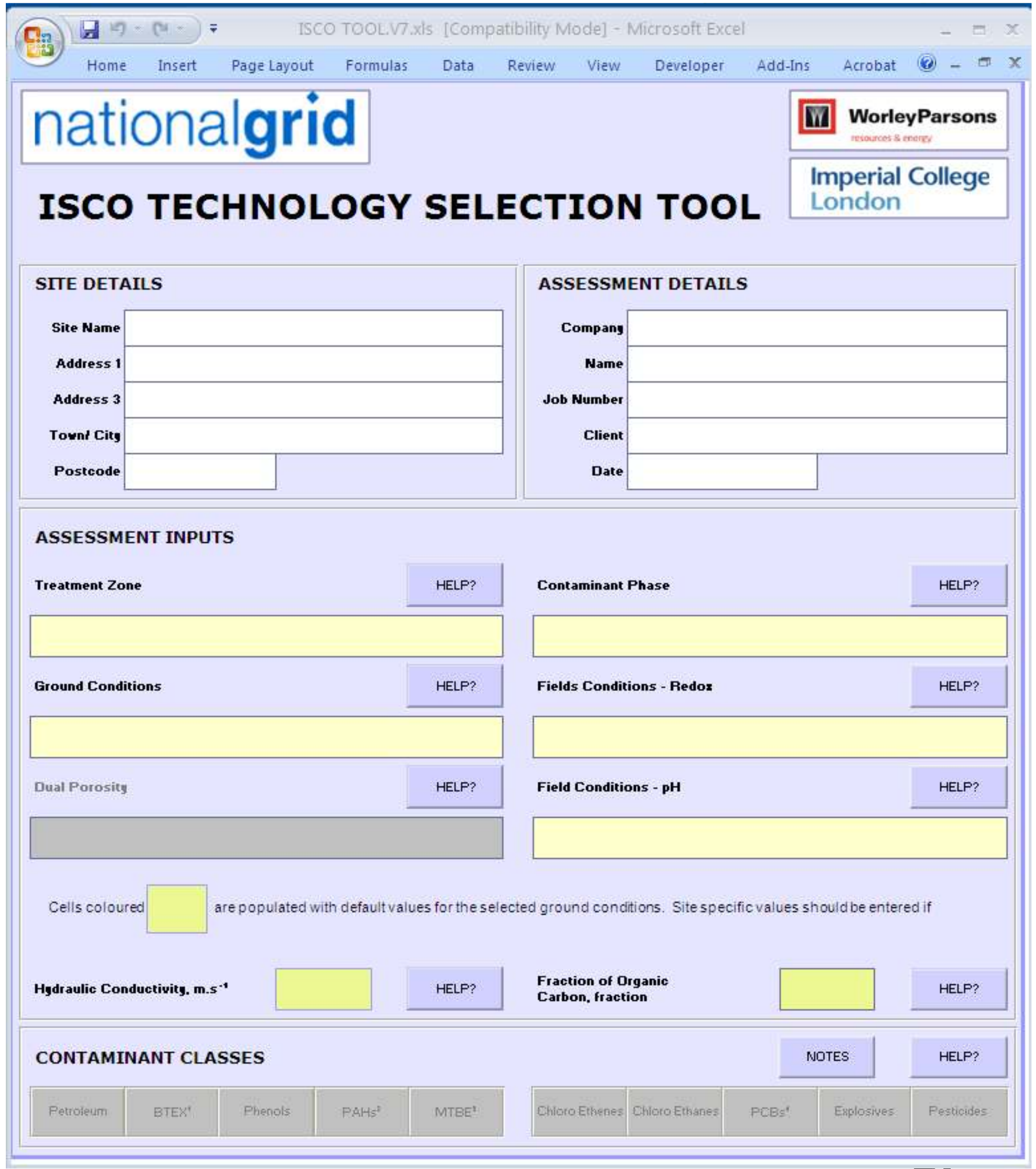


CL:AIRE

Modelling outcomes

- Importance of hydraulic fracturing in the efficient delivery of oxidant identified
- New model of hydraulic fracturing with ‘leak-off’ developed
- Decision Support Tool (Excel spreadsheet incorporating Visual Basic macros) developed to aid use of ISCO in remediation decision making





Decision support tool will soon be available on CL:AIRE website and bulletin will be completed later this year

TDP31 Case Study

Demonstration of the Arvia® Process of adsorption coupled with electrochemical regeneration for the on-site, ex-situ, decomposition of organic contaminants in groundwater

The Arvia technology is based on two key elements:

(i) A novel, non-porous, highly conducting and dense carbon-based adsorbent material (Nyex®) for the adsorption of organic contaminants, which is capable of rapid electrochemical regeneration.

(ii) A treatment unit where adsorption and electrochemical regeneration can be achieved within a single unit, either continuously or sequentially

Main Processes

Adsorption

- Adsorption is achieved by mixing the Nyex® and effluent through fluidising the adsorbent particles, where vigorous mixing and the non-porous nature of the Nyex® results in quick adsorption.

Sedimentation

- Sedimentation is achieved when the fluidising air is switched off and the dense Nyex® particles settle rapidly under the influence of gravity to form a bed.

Electrochemical Destruction

- Two electrodes are placed either side of the bed of particles and a direct electric current is passed through the bed which destroys the pollutant through direct and indirect oxidation of the organic matter to water, carbon dioxide and a small amount of hydrogen. This also serves to regenerate the adsorbent ready for immediate reuse.

Continuous treatment unit

Sequential batch unit

Sites

- Site 1 - Former agrochemical facility (Vertase FLI)
  - treat a portion of the effluent after biological treatment
- Site 2 - Petrol station site (Geo2 Remediation)
  - treat petrol/diesel contaminants using Arvia’s 6 cell pilot-scale sequential batch reactor

- Results

- Comparison with GAC
  - Carbon footprint
  - Gaseous emissions
  - Costs

- Final report by end of 2010 including lessons learned

SuRF-UK - Background

- Established in 2007, following the lead of SuRF.
- UK-based collaboration of regulators, industry, academics and consultants. Open forum meetings.
- Independent co-ordination by CL:AIRE (www.claire.co.uk/surfuk)
- Focus on holistic sustainability assessment of
  - Remediation input to high-level land-use planning
  - Remediation input to overall site / project design (‘Better by Design’)
  - Remedial strategy selection and remediation technology selection
  - Remediation implementation and verification
- Goals
  - A framework for assessing sustainable remediation
  - Sustainability indicator review

Steering Committee

- Prof. Jonathan Smith, Shell Global Solutions (Chair)
- Prof. Paul Bardos, r3 Environmental Technology Ltd
- Dr Brian Bone, independent
- Dr Richard Boyle, Homes and Communities Agency
- Dr David Ellis, Du Pont
- Nicola Harries, CL:AIRE
- Alison Hukin, Environment Agency
- Scott Lewis, National Grid Properties Ltd

Drivers

- Industry (SAGTA)
  - Good practice, business ethics, sustainable procurement, CSR
- Regulatory (and indeed cross-sectoral)
  - Appropriate and reasonable solutions
  - Soil Framework Directive (draft); Water Framework Directive
- Planning
  - Sustainability tests in planning applications
  - Sustainability criteria in regional and local spatial planning
- Cross-sectoral backing in the UK
- Also response to worldwide interest:
  - EU (NICOLE, SuRF-UK, SuRF-NL?, EURODEMO+)
  - USA (e.g. SuRF, US EPA “green remediation”, ASTM)
  - Canada, Australia

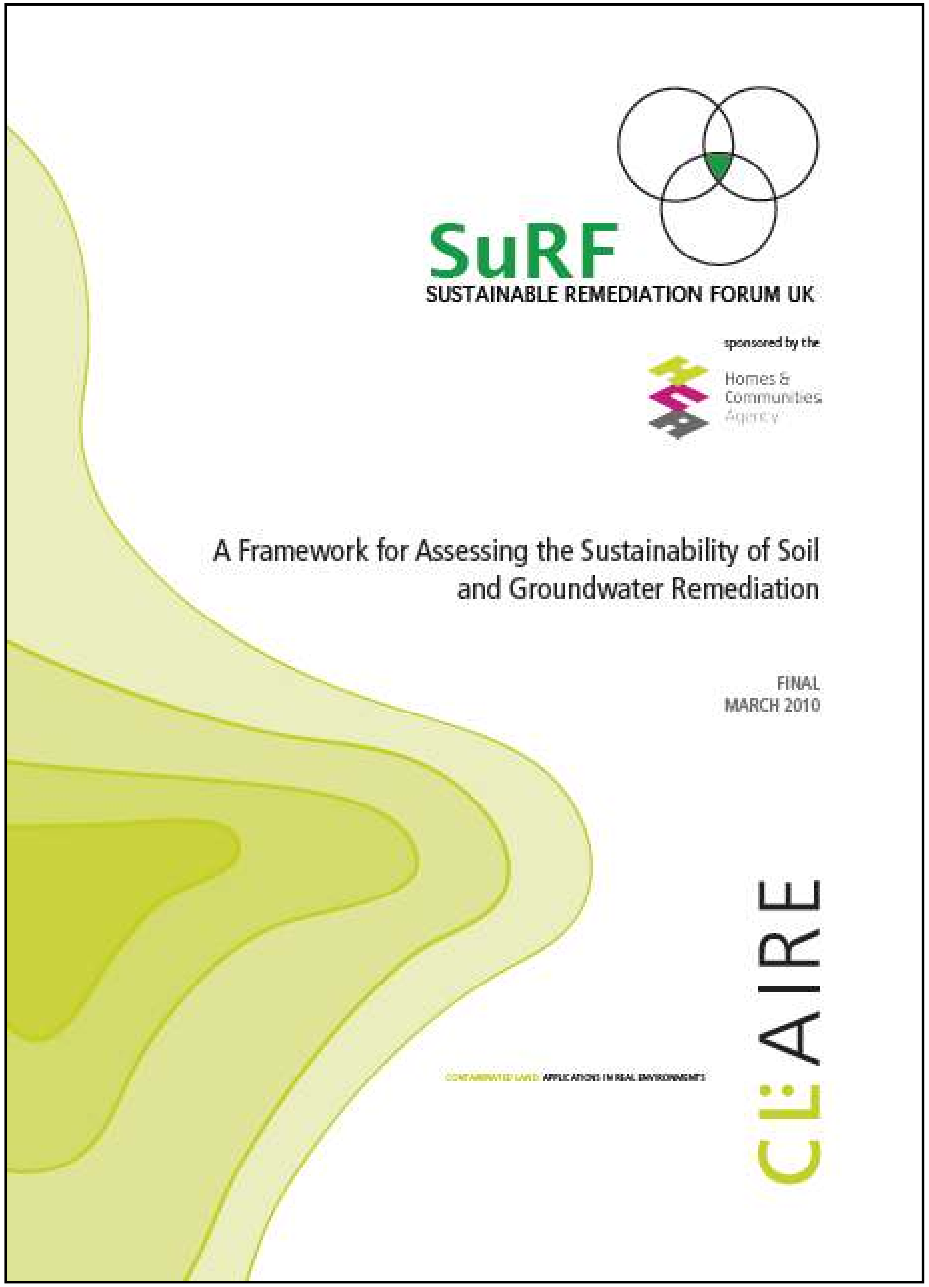
Sustainable remediation: SuRF-UK definition

- ‘*the practice of demonstrating, in terms of* ***environmental, economic*** *and* ***social*** *indicators****,*** *that the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a balanced decision-making process*’

SuRF-UK: Key principles

- Optimise risk-management based on consideration of social, environmental and economic factors, but always ensure:
  - **Principle 1:** Protection of human health and the wider environment
  - **Principle 2:** Safe working practices
  - **Principle 3:** Consistent, clear and reproducible evidence-based decision-making
  - **Principle 4:** Record keeping and transparent reporting.
  - **Principle 5:** Good governance and stakeholder involvement
  - **Principle 6:** Sound science

SuRF-UK, www.claire.co.uk/surfuk


SuRF
SUSTAINABLE REMEDIATION FORUM UK

sponsored by the
Homes & Communities Agency

A Framework for Assessing the Sustainability of Soil and Groundwater Remediation

FINAL
MARCH 2010

CONTAMINATED LAND: APPLICATIONS IN REAL ENVIRONMENTS
CL:AIRE

John Palfalvy
Policy Advisor, Brownfield Land
Department of Communities and Local Government

Tom Coles
Contaminated Land Policy Team
Department for Environment, Food and Rural Affairs

Trevor Beattie
Director Strategy, Performance, Policy & Research
Homes and Communities Agency

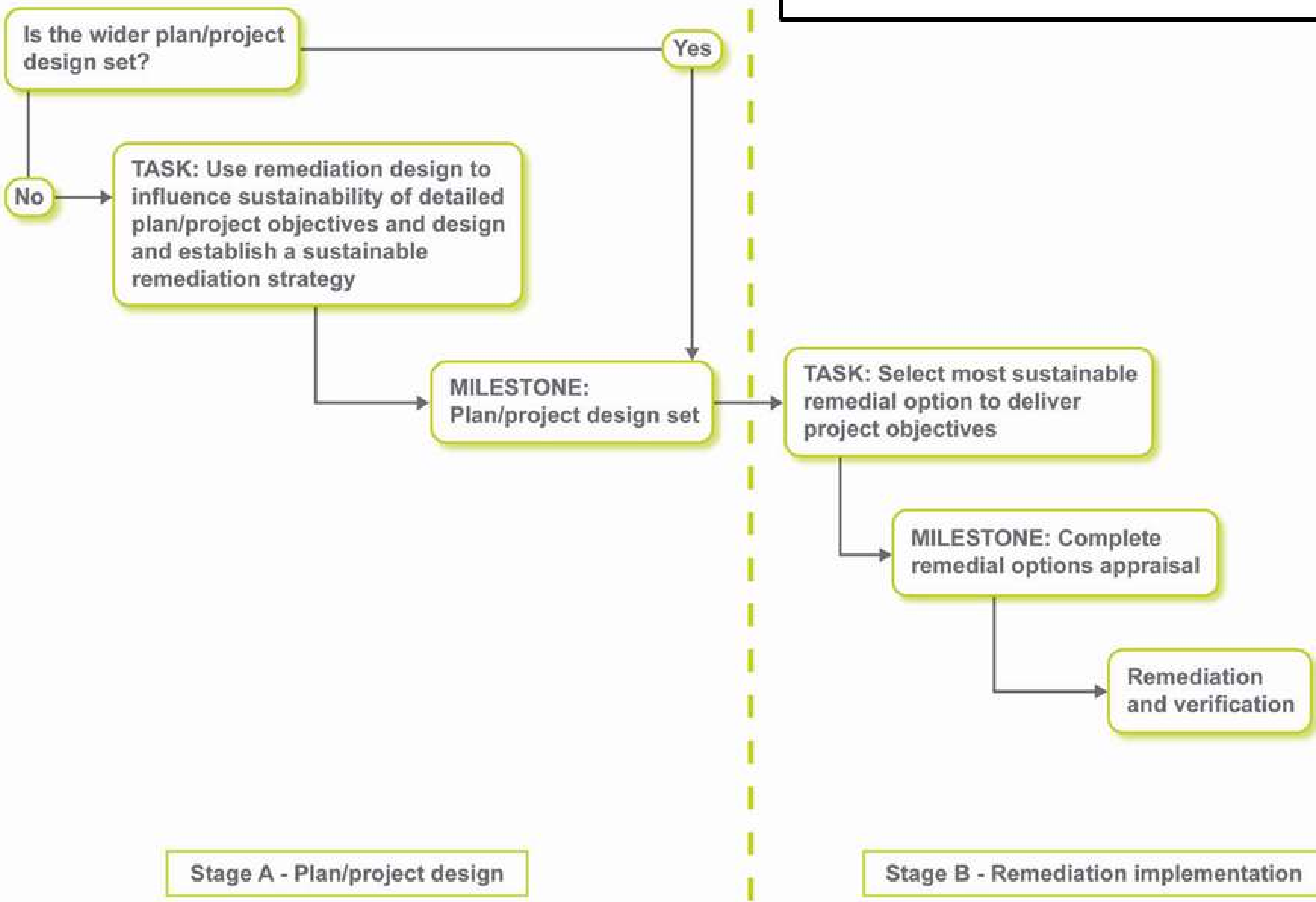
Gareth Hall
Director General, Department for the Economy and Transport
Welsh Assembly

Sheena Engineer
Land Quality Policy Manager
Environment Agency

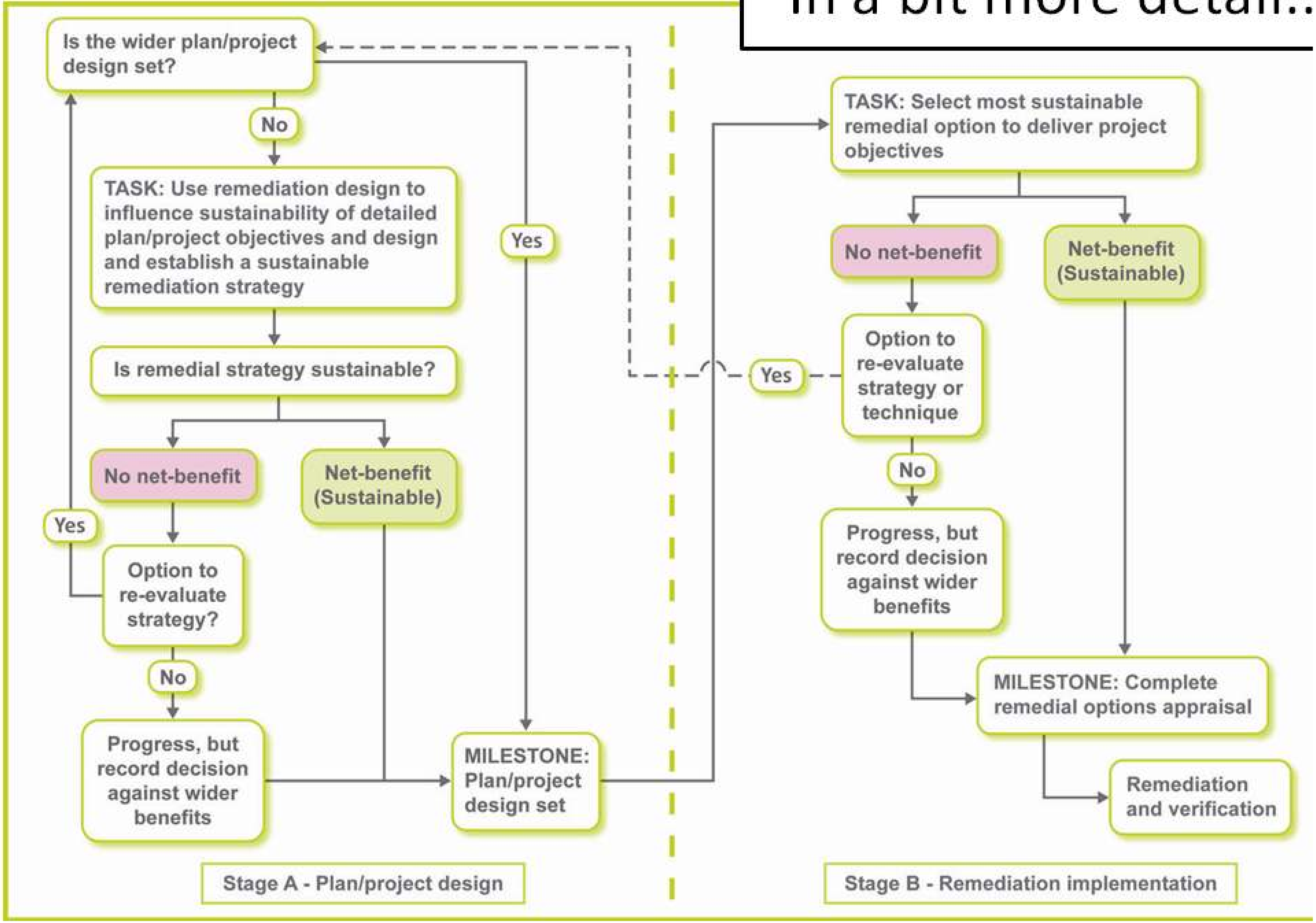
Calum MacDonald
Director of Environmental and Organisational Strategy
Scottish Environmental Protection Agency

Theresa Kearney
Principal Scientific Officer
Northern Ireland Environment Agency within the Department of the Environment

SuRF-UK framework



In a bit more detail..



Sustainability is wide-ranging in its scope: SuRF-UK headlines (in development)

Environmental	Social	Economic
1. Impacts on air (including climate change; 2. Impacts on soil; 3. Impacts on water; 4. Impacts on ecology; 5. Use of natural resources and generation of wastes; 6. Intrusiveness.	1. Impacts on human health and safety; 2. Ethical and equity considerations; 3. Impacts on neighbourhoods or regions; 4. Community involvement and satisfaction; 5. Compliance with policy objectives and strategies; 6. Uncertainty and evidence.	1. Direct economic costs and benefits; 2. Indirect economic costs and benefits; 3. Employment and capital gain; 4. Gearing; 5. Life-span and 'project risks'; 6. Project flexibility.

SuRF-UK Phase 2

- Objectives:
  - Trial the framework with real cases studies
  - Investigate the indicator categories further
  - Benchmark different assessment methods for the same site(s)
- Timescale
  - April 2010 to April 2011

[NB. Defra-funded research project, applying the SuRF-UK sustainability indicators to remediation technologies. Report released by end of year.]

Summary of key achievements and ongoing initiatives

- Evaluated and Approved over 50 Projects through Technology & Research Group
- Produced over 70 Publications
- Dissemination to Contacts Database of ~5000
- Always looking for new demonstration & research projects & industry initiatives (DefCoP & Cluster, SuRF-UK, Qualifications, development of CL:AIRE Membership etc)

Thank you

rob.sweeney@claire.co.uk

www.claire.co.uk

Remember, remember the 4th November….
The Story of Enabling Works at the Olympic Park
CL:AIRE Conference at One Great George Street

CONTAMINATED LAND: APPLICATIONS IN REAL ENVIRONMENTS

CL:AIRE