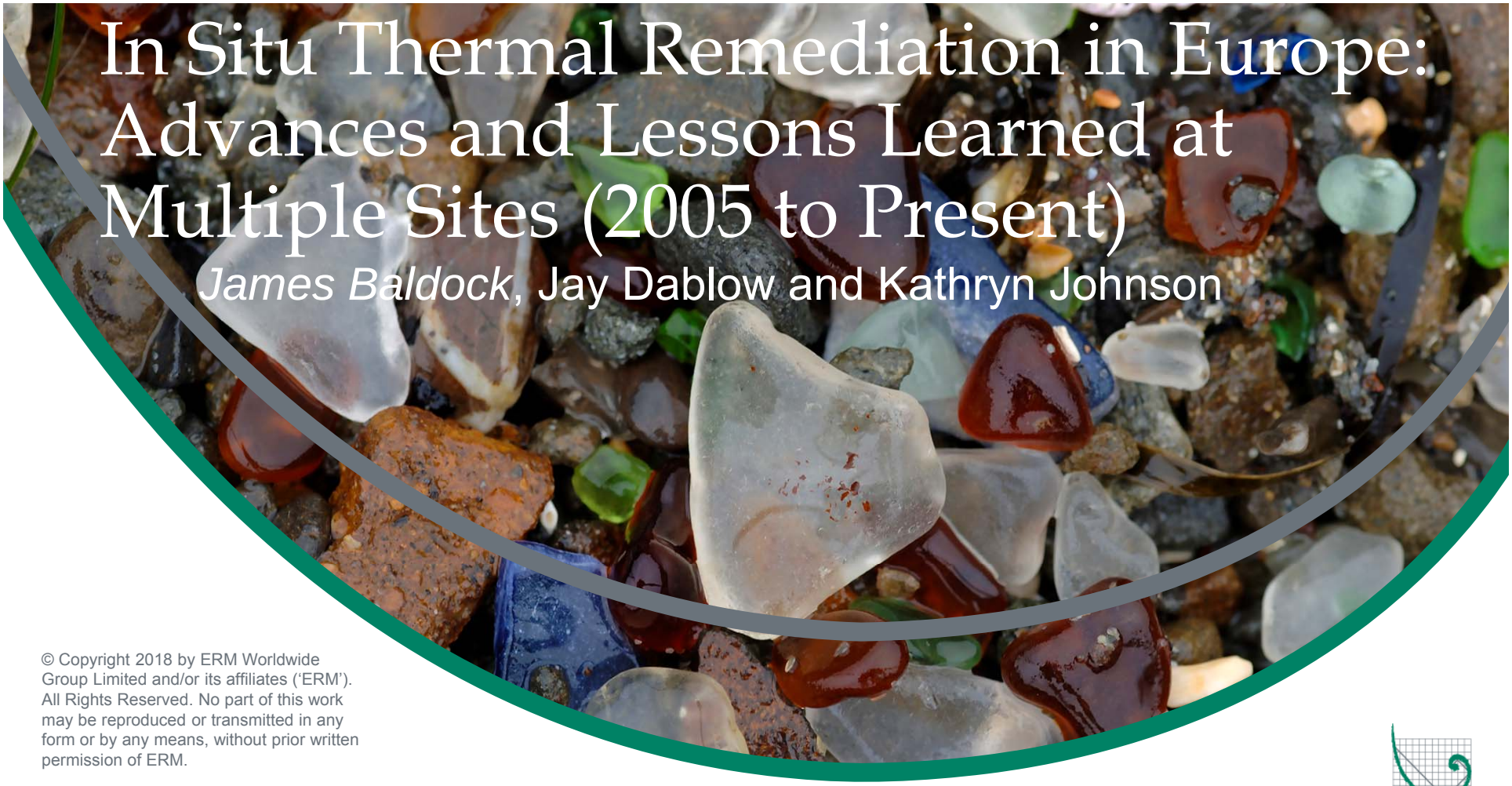
In Situ Thermal Remediation in Europe: Advances and Lessons Learned at Multiple Sites (2005 to Present)

James Baldock, Jay Dablow and Kathryn Johnson



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Agenda Slide

01Introduction

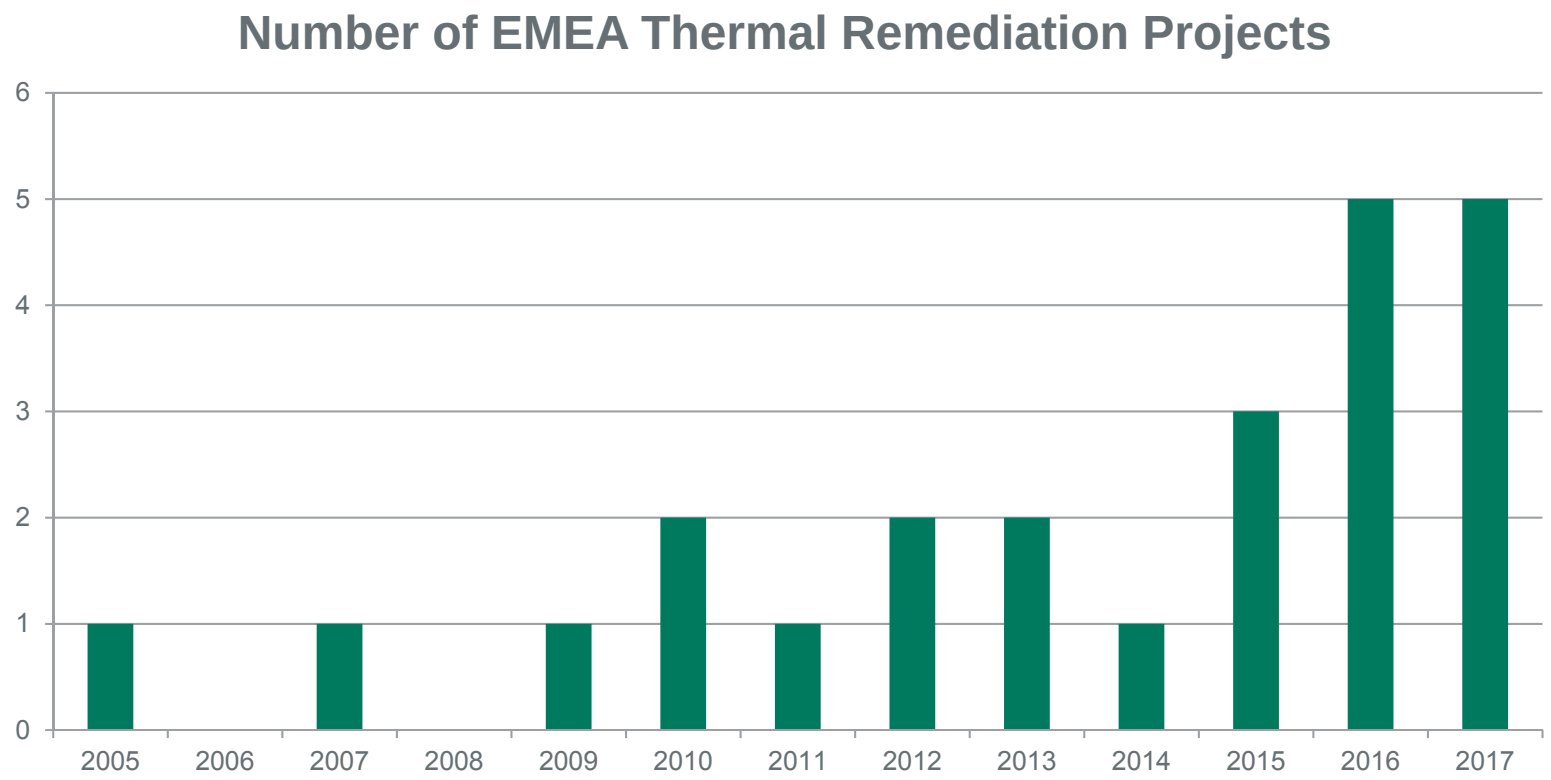
02 European Case Studies

03 Lessons Learned

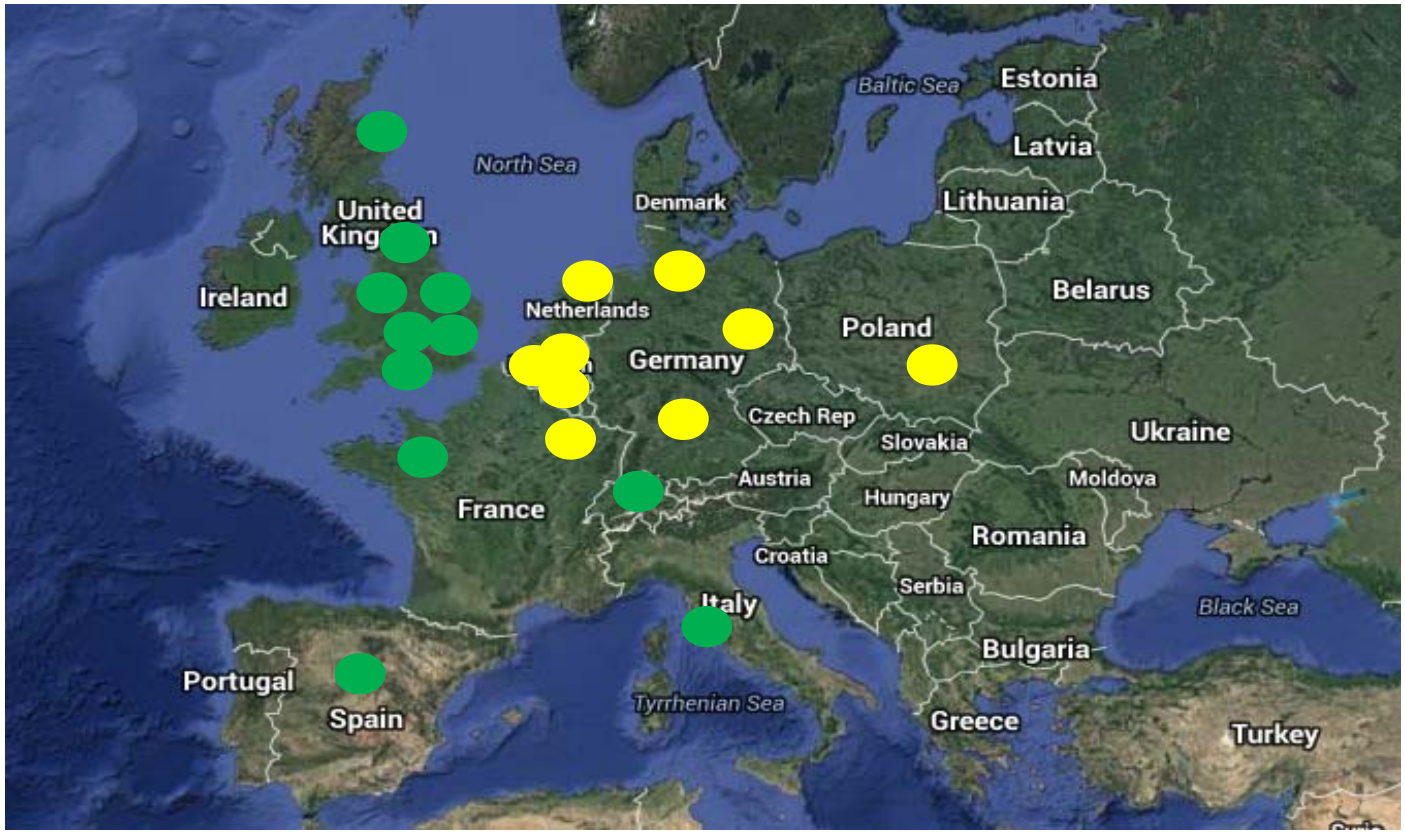
04 Summary

05 Future Trends

Introduction



Introduction



Full scale

Feasibility Assessment

Site 1 (2005): Overview

Site 1 (2005): Lessons Learned

- Focus upon ‘will it work’ rather than ‘how can we do this efficiently:
  - System over-designed
  - Pilot test on the things we knew
  - Construction took way longer than expected
  - Steam injected 24/7 into heating locations – no optimization
  - Basic temperature tracking only

Schedule and Budget Delivery

Technical Delivery

Site 2 (2009): Overview

Site 2 (2009): Lessons Learned (1)

- Simpler Contract Structure
  - Engineering contract versus solution driven service
  - Consider lump sum instead of risk/reward, or if risk/reward think carefully about the structure
  - Use ‘Turnkey’ model for remediation delivery, where appropriate

- Contractor Selection
  - Change of key personnel in small companies can materially change your relationship – how do you avoid that?
  - Broader economic context hard to foresee

Contractual Arrangement

Contractor Approach

Schedule and Budget Delivery

Site 2 (2009): Lessons Learned (2)

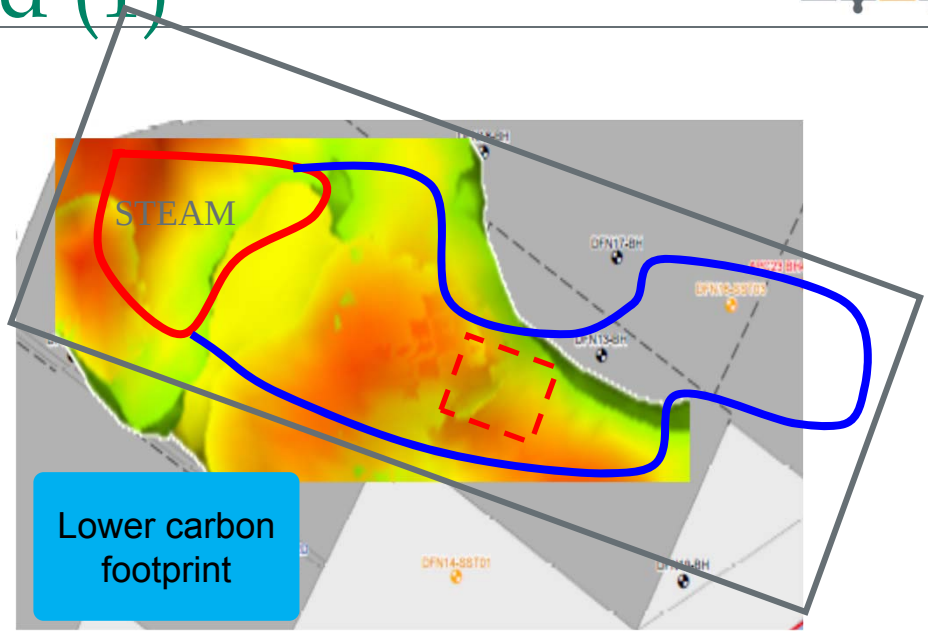
- Technical Aspects
  - Drilling issues (Turnkey approach)
  - Robust HAZID/HAZOP during the design process
  - Bench Test – tar issues – recognised, but would have provided better evaluation of conditions under heating before project starts

Technical Delivery/ Safety

Schedule and Budget Delivery

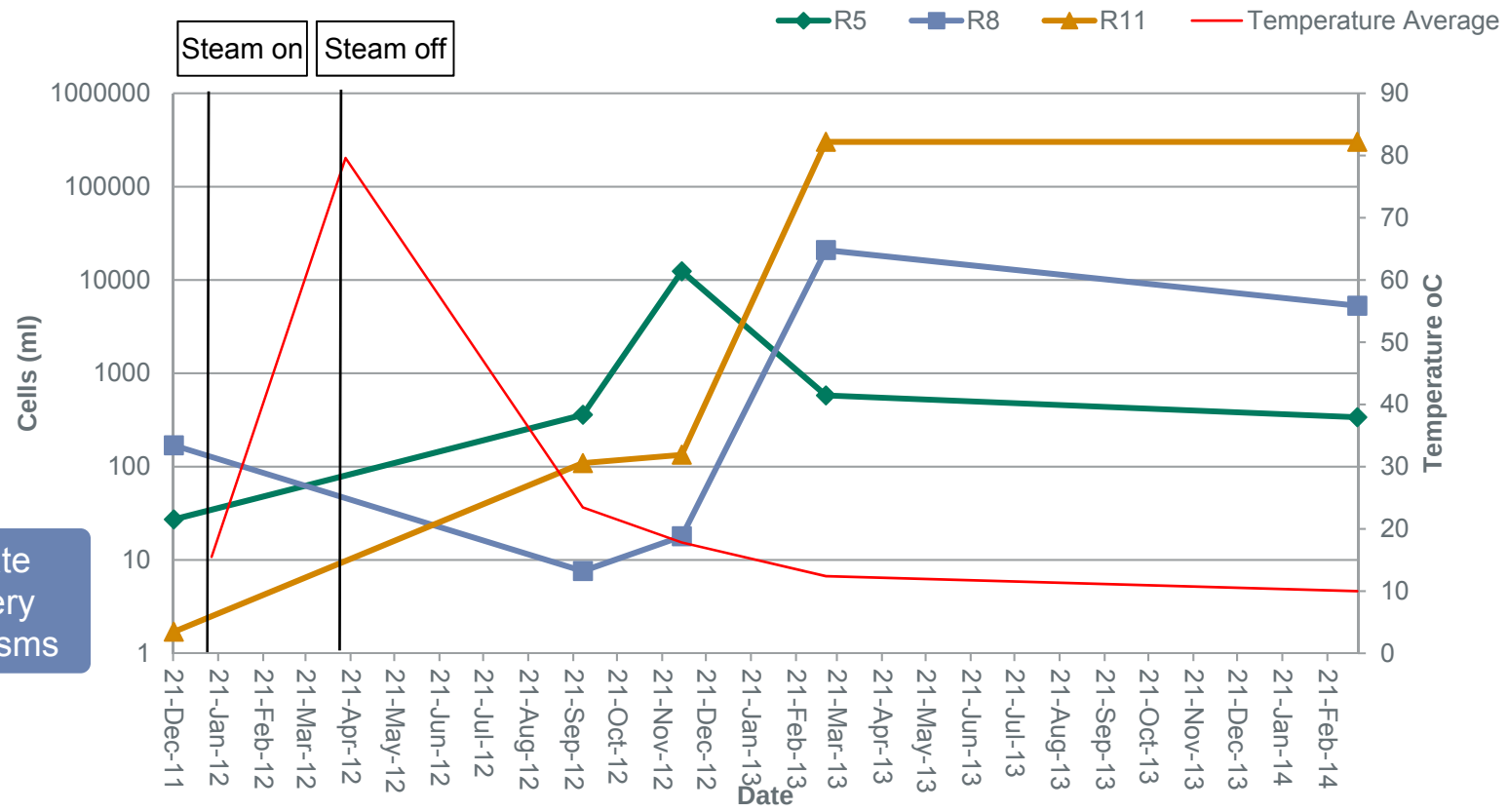
Site 3 (2012): Overview

Site 3: Lessons Learned (1)



- Design issues – still no formal process safety review
- BUT: HRSC benefits and optimisation carried out
- Biological/thermal combination developing

Site 3: Lessons Learnt (2)



Alternate Recovery Mechanisms

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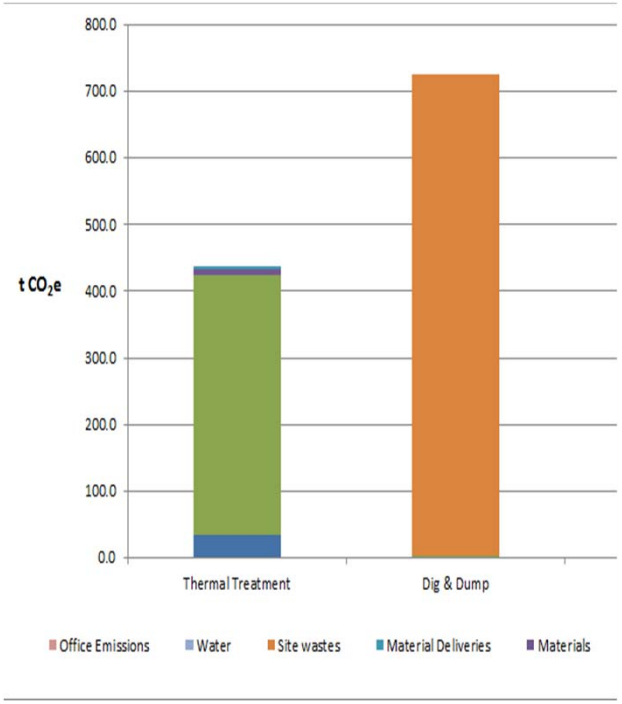
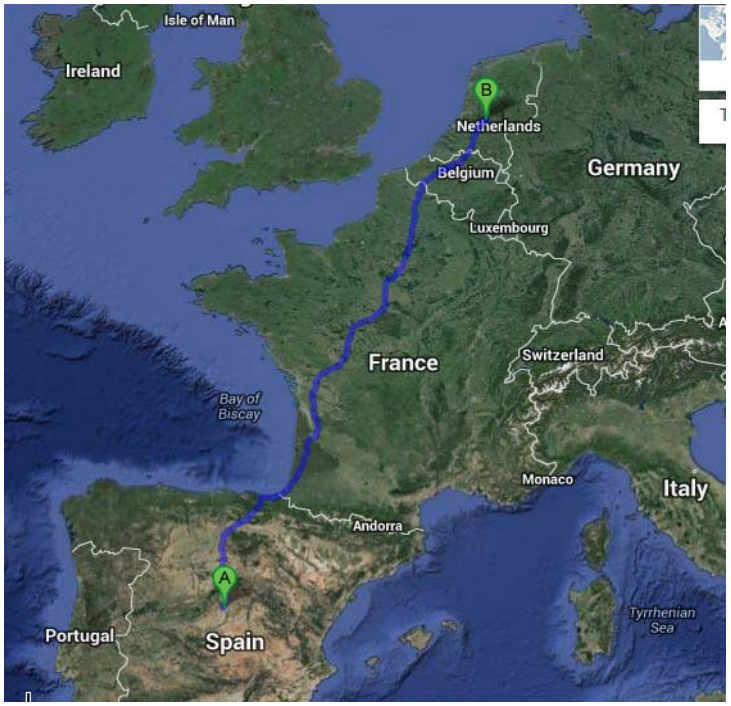
Site 4 (2013): Overview

Site 4: Lessons Learned (1)



Lower carbon footprint



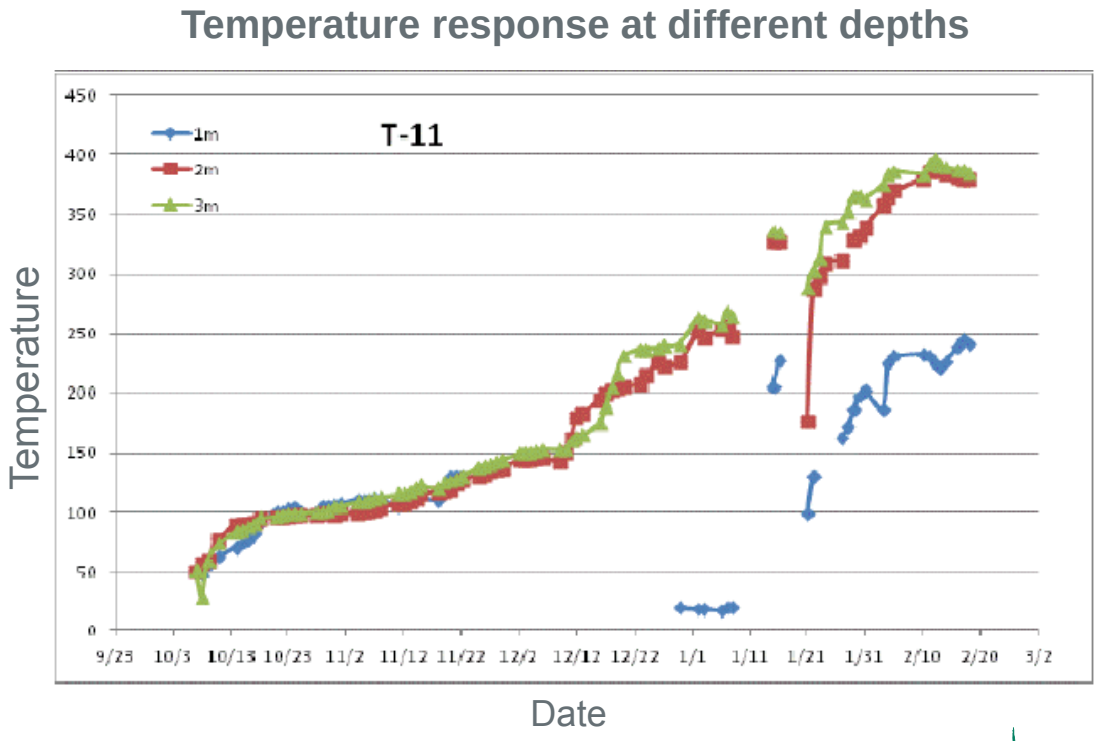
A - Site

B - Landfill

Site 4: Lessons Learned (2)

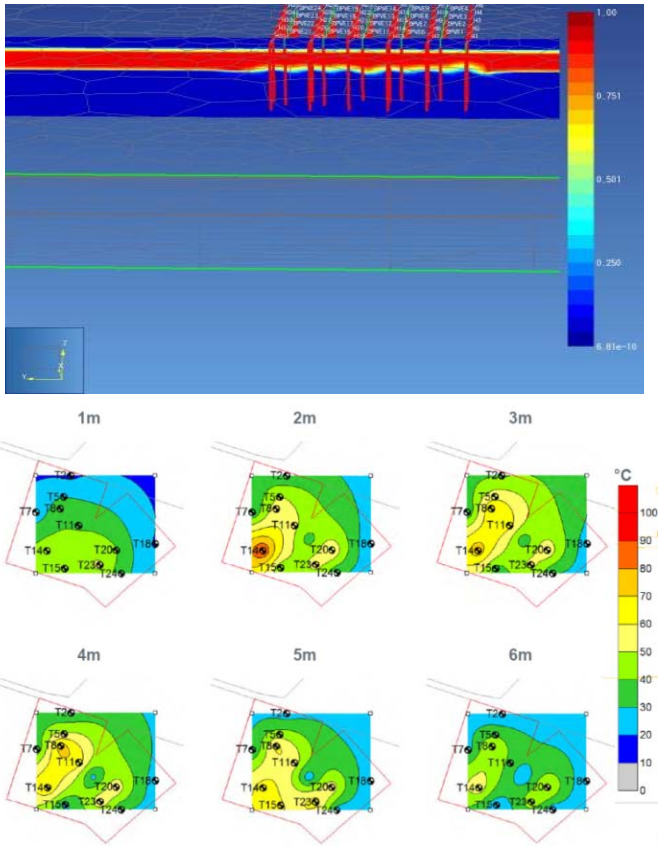
Schedule and Budget Delivery

Technical Delivery/ Safety



Site 5: (2015): Overview

Site 5: Lessons Learned



- Thermal modelling – Petrasim
- Best Management Practises in design (USEPA)
- Automatic thermocouples – link to PLC
- Low Temperature Volatilisation

EPA United States Environmental Protection Agency

Office of Solid Waste and Emergency Response (5203P)

Green Remediation Best Management Practices:

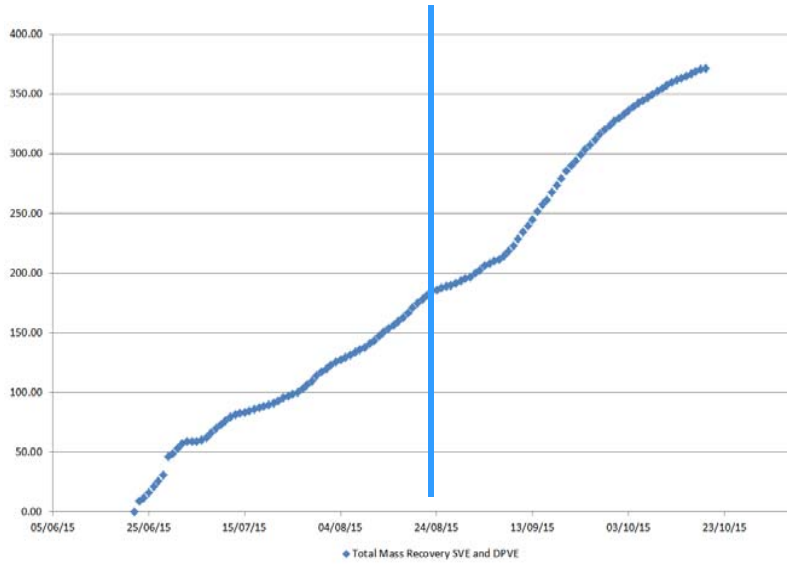
Implementing In Situ Thermal Technologies

Low Temperature Volatilization (LTV)

- Initial target temperature based on traditional volatilization
- LTV Concept: CO_2 generated and released can also remove VOC contamination. LTV reduced CO_2 consumption by 16%
- At this site lowered treatment temperatures from ~150ºC to an average of 80ºC (heating time 80 days compared to the 120 modelled)

Lower carbon footprint

Schedule and Budget Delivery



Main Lessons Learned

- Collaboration is key to the successful use of thermal technologies: it works and is safe!
- Multiple benefits of carbon footprint reduction from design to implementation
- Technology has not changed significantly – but innovation has reduced energy, cost and time.

Lower carbon footprint	Schedule and Budget Delivery	Technical Delivery/ Safety	Contractor Approach	Contractual Arrangement	Alternate Recovery Mechanisms

Summary

	2005	2010	2015
Contract	Hire turnkey contractor/ difficult contractual endpoint	Less difficult endpoint/ collaboration improving	ERM design/contractor supply equipment
Safety	Personal safety good – but no HAZOP	Basic HAZOP	Full HAZOP
Carbon Footprint Reduction	Who cares?!	Included in options appraisal	Low temperature application biological links process equipment design
Technical (Design)	Over designed	Field trials basic models	Field trials full models bench tests
Technical (Installation)	Bentonite seals	Thermal grout	Thermal grout
Technical (Monitoring)	Water temperatures in wells	Manual thermocouple measurement	Automatic thermocouple database/website

Future Trends?

- More thermal remediation projects and geographical spread - as the remaining contaminated land sites become more complex
- New geographies: Once you do one, others follow
- Temperature decrease:
  - LTV approach to reduce the target treatment temperature from that traditionally applied
  - Use of alternative recovery mechanisms to volatilisation to recover contaminant mass, and/or integration with follow on biological approaches
- Technology increase:
  - Real time monitoring/data management
  - Multiple heating techniques

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Conference on Remediation of Chlorinated and Recalcitrant Compounds

April 8-12, 2018 | Palm Springs, CA

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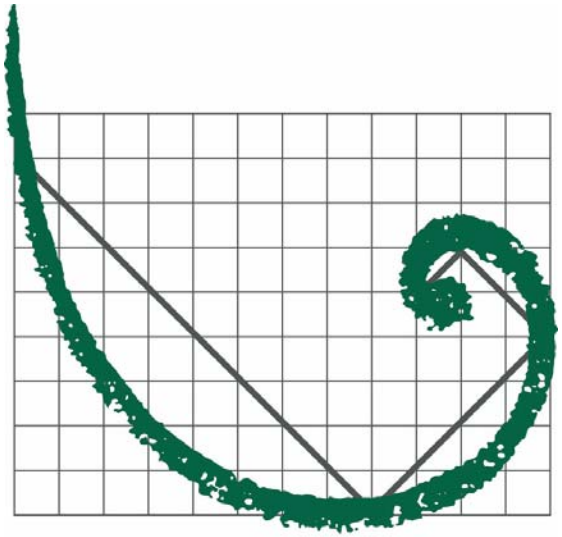

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