Controlled Waters Risk Assessment for Chlorinated Solvents

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Presentation Structure

- Some context
- From CSM to DQRA
- Key data
  - Especially biodegradation
- Implementing the assessment
- Interpreting the output
- Conclusions

Starting Point

- I will take it that:
  - We are all familiar with the basic principles of risk assessment and the general behaviour of chlorinated solvents
- My presentation will, therefore:
  - Highlight a few key issues to bear in mind when undertaking or reviewing a controlled waters risk assessment for dissolved-phase chlorinated solvents

Exclusions

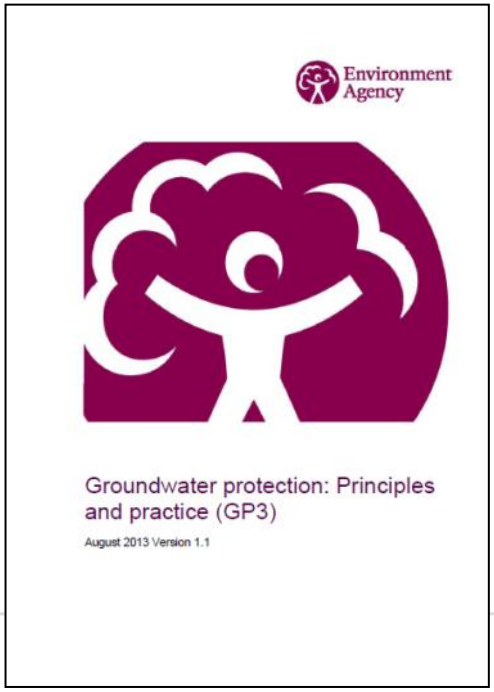
- Sampling and analysis
- Conceptual site models (in general)
- General chemical and hydrogeological considerations
- NAPL migration
- “Serious” hydrogeological modelling
- Etc., etc.

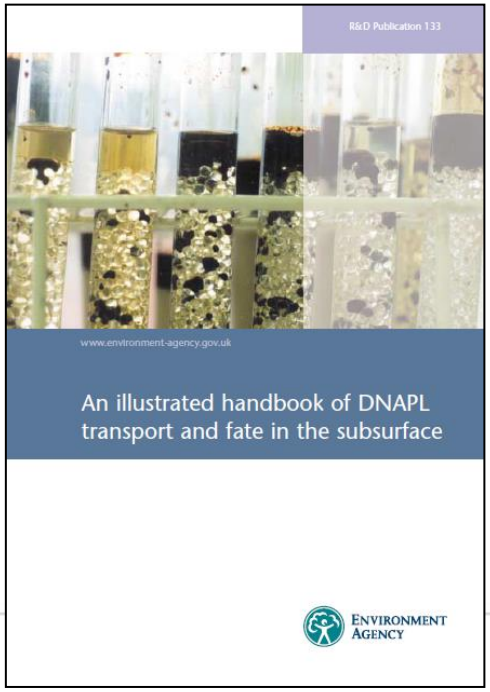
But I may touch on some of these to make specific points about controlled waters DQRA

Know the Guidance*

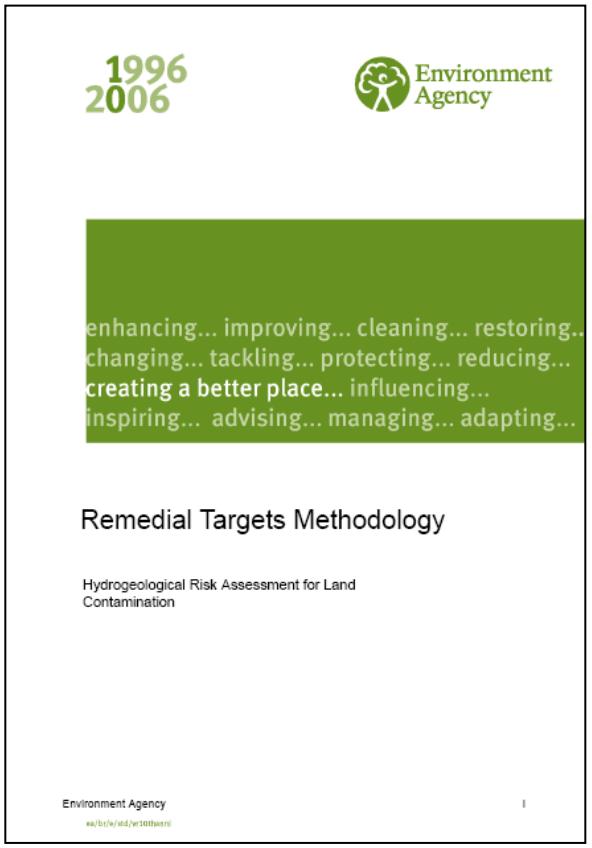
** And whether it applies in England, Scotland ,Wales and/or Northern Ireland*

- Many common hassles and errors can be avoided by reading the relevant guidance, e.g.





Know the Guidance
The Remedial Targets Methodology (RTM)

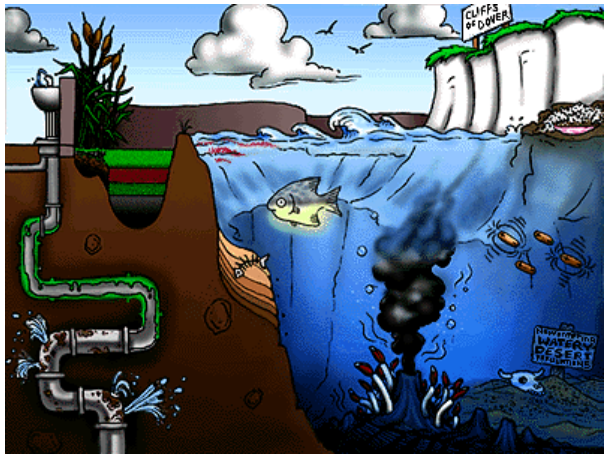


- Provides a phased approach ("Levels")
- It's a *framework*
- The Excel worksheet is just <u>one</u> (simple) tool provided to help in (parts of) the assessment

RTM Levels

Level	Assessment Includes	
	Soil Source	**GW Source**
1	Compare source pore water concentrations with target conc'n(s)	N.A.
2	Attenuation in the unsaturated zone & dilution at water table	Compare GW data with target conc'n(s)
3	Attenuation along GW flow path to the defined compliance point	
4	Dilution in the receptor	

From CSM to DQRA – 1



- Source
  - What and where?
  - Size?
  - Matrix diffusion?
- Pathway
  - Realistic flow pathway(s)
    - Model selection
    - How to represent?
  - Preferential flow
  - Seasonal variability
  - Abstraction effects

From CSM to DQRA – 2

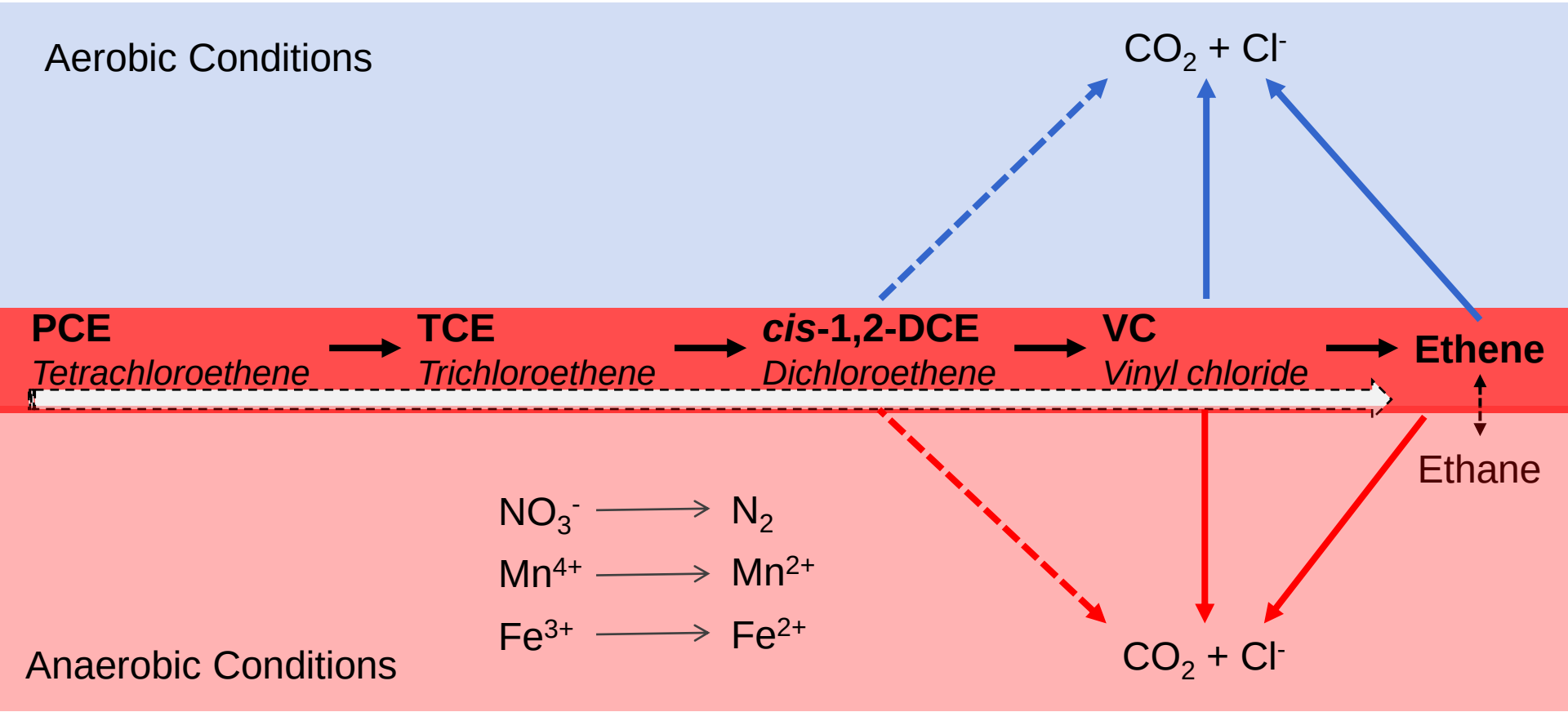
- Attenuation Mechanisms
  - What might make a difference to the outcome?
  - What evidence is there?
  - Do I understand them?
- Receptor
  - Sensitivity and objective(s) of protection
    - Appropriate compliance point?
  - Additional attenuation?
  - Magnitude of impact
    - Size
    - Time-scale

And remember the reason(s) for doing the DQRA!

Key Data

- Understand the models and their sensitivity
  - A little more on this later
- There is a balance to be had between “book” and site-specific data
  - Money, time, complexity, site sensitivity, etc.
  - Of particular importance:
    - Hydrogeological parameters
    - Biodegradation evidence

Chlorinated Solvent Biodegradation



A generally similar story applies for other chlorinated solvent families

Lines of Evidence

- Hydrochemical data
  - Contaminants of concern
  - End-products
    - Ethene and ethane
    - (Alkalinity, chloride)
  - Electron donors for dehalorespiration
    - Co-contaminants or natural organic matter
  - Electron accepting processes
    - Redox, DO, nitrate, Mn(II), Fe(II), sulphate, methane

CSM should drive decision-making

Lines of Evidence

- More specialist data
  - Redox chemistry
    - Dissolved hydrogen
    - (CO_2 traps)
  - Stable isotope analysis
  - Microbiological
    - Molecular biological testing
    - Biotraps
    - (Lab. microcosms)

Infrequently used but may help in complex, large or high sensitivity cases

http://cms.serdp-estcp.org/projects/tools/er-201211/index.html


Guidance on the Assessment and Monitoring of Natural Attentuation of Contaminants in Groundwater

R&D Publication 95

M. A. Carey[1], J. R. Finnamore[2], M. J. Morrey[1] & P.A. Marsland[1]

Incorporating Degradation into a Model

- Degradation chains
  - Calculate a combined degradation rate from start to end of decay chain
    - Deriving an appropriate value?
  - Calculate sequential steps individually
    - Likely very conservative
  - Model the components separately
    - Potentially insufficiently conservative
- In which phases?
  - Field-relevant data should have accommodated degradation in all phases

Selecting a Model – 1.
The “Old Favourites”

- RTM Spreadsheet
- CONSIM
- RAM*

Allow probabilistic modelling

- RISC5
- RBCA Toolkit

- Custom calculations*

* *Can include Level 4*

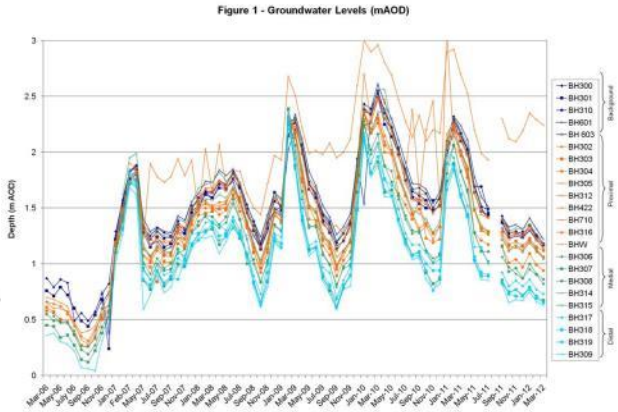
Selecting a Model – 2.
Some Specific Options

- Biochlor
  - Domenico analytical solution for solute transport
  - 1-D advection
  - 3-D dispersion
  - Linear sorption
  - Biodegradation
    - Sequential 1st-order decay in one or two zones
- REMChlor
  - Analytical model
  - Time-dependent source mass discharge to plume
  - 1-D plume model including 1st-order sequential decay
    - Processes and rates variable over time and distance

http://www.epa.gov/ada/csmos/index.html

Interpreting the Output
(Part of “Risk Evaluation”)

- Sensitivity analysis
- How conservative is the assessment
  - Residual conservatism ?
  - Implications of noisy data?
- What timescales are involved?
- Verification
  - Reality check against existing dataset
  - Further data to check/refine?
  - Remediation



Summing Up

- The CSM is crucial
- Collect the correct data
  - And understand the dataset(s)
- Choose the appropriate model(s)
  - RTM is a framework, not an instruction book
- Risk evaluation is more important than modelling
  - A model is not reality