



GREEN REMEDIATION 2009
COPENHAGEN

Decision Support Tools
to support green
remediation in a case
study

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INTRODUCTION

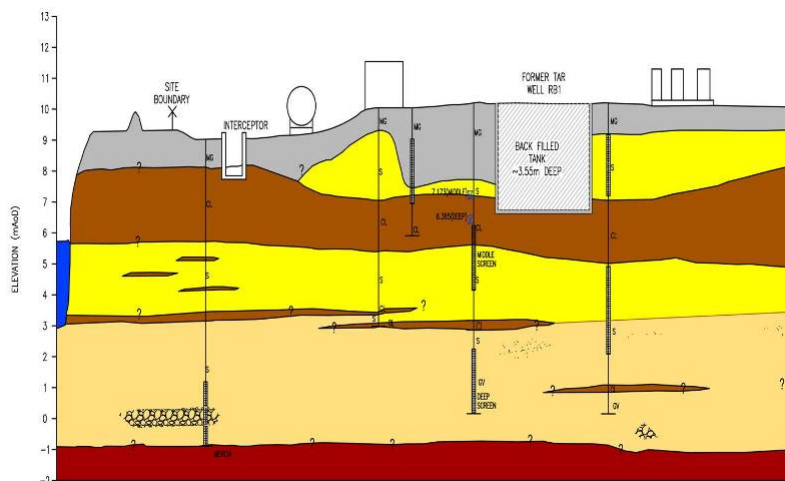
- Introduction to site and setting
- Risk Drivers and context
- Conventional analysis
- Green Remediation Assessment
- Revised framework

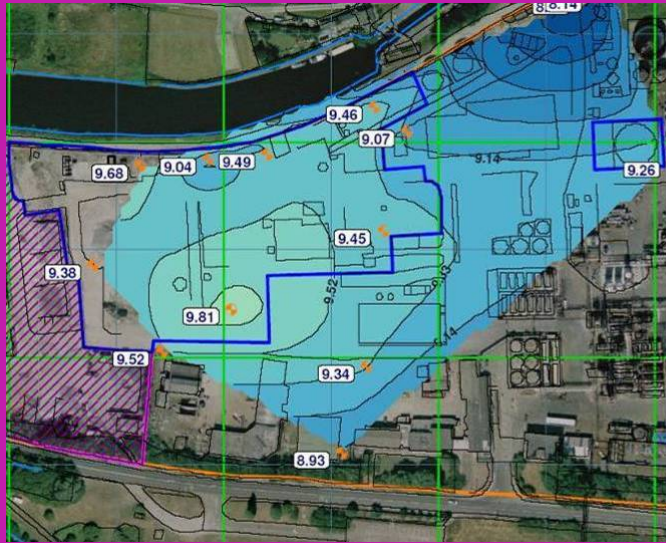


HISTORY



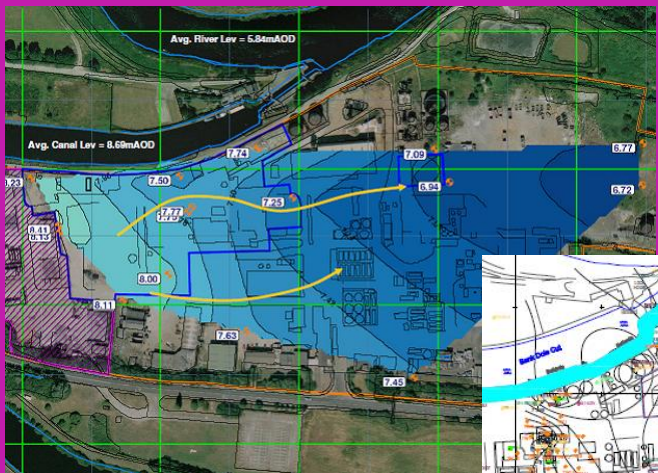
GEOLOGY





SHALLOW GW

- Unconfined
- Perched system
- Isolated

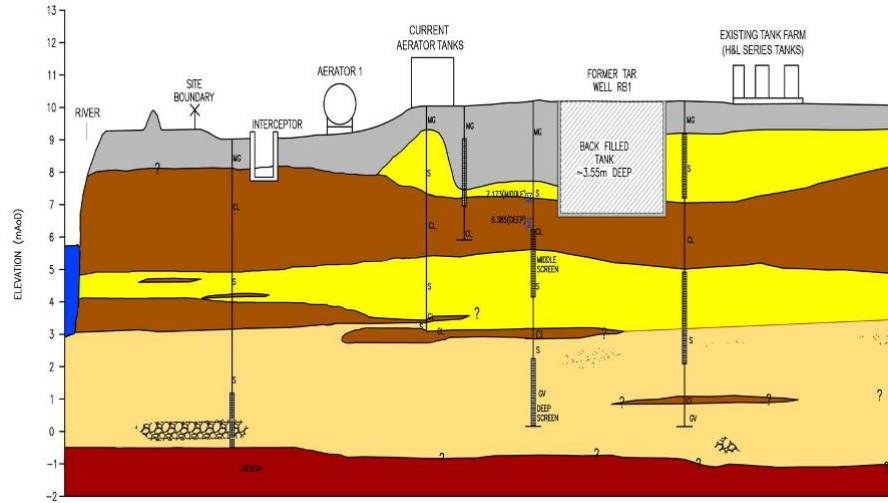


MIDDLE GW

- Confined
- Silty Sand
- Lines of evidence of connection to river



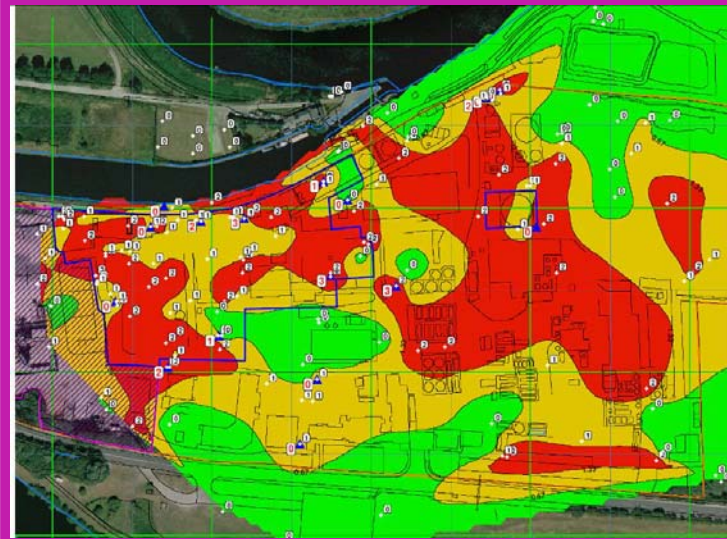
GEOLOGY



DEEP GW

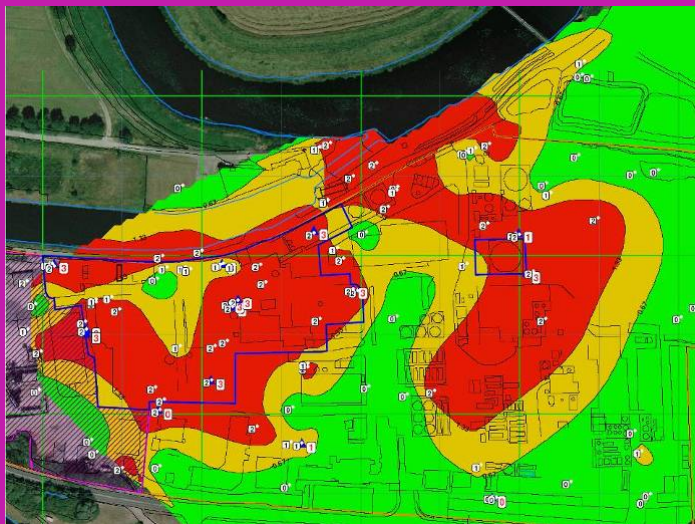
- Confined
- Some influence from River
- Also from basin wide recharge





NAPL Shallow

- DNAPL
- LNAPL
- Creosote
- Naphthalene



NAPL Middle

- DNAPL
- LNAPL
- Creosote
- Naphthalene





NAPL Deep

- little evidence for NAPL



RISK ASSESSMENT

- Human health – ongoing industrial use as a chemical works
- Controlled Water – minor observable impact to river in one location
- Sediments not impacted
- No discernible effects in river

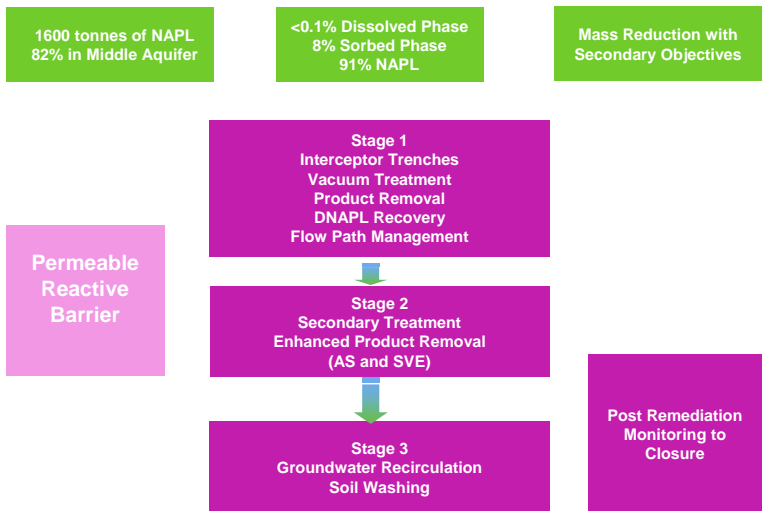


Original Remedial Options Appraisal

- Option 1 – Pump and treat from shallow groundwater, Multiphase extraction from middle aquifer, with polishing by groundwater recirculation,
- Option 2 - containment wall and more limited extraction scheme
- Option 3 – PRB, with pump and treat from Shallow
- Option 4 – Ex-situ bio for shallow with MPV from middle

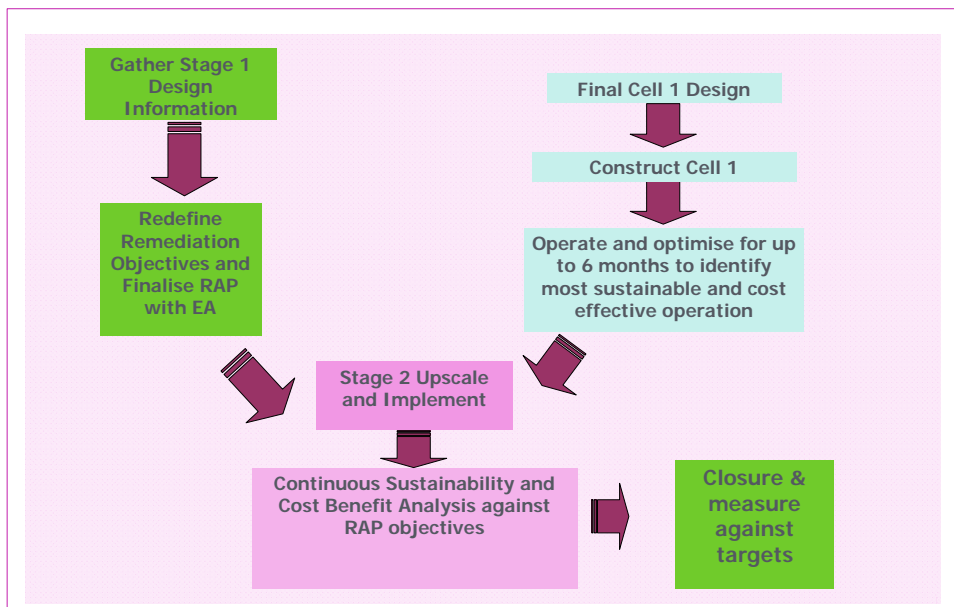


Agreed options with regulator



risk / opportunity review

Risk	Opportunity
Conservative remediation objectives	<ul style="list-style-type: none"> Commence stage 1 works and renegotiate secondary targets Establish mass reduction with iterative cost benefit analysis Sustainability appraisal?
Time	<ul style="list-style-type: none"> As above?
Product disposal costs	<ul style="list-style-type: none"> Alternative fuel source?
Carbon use/reuse	<ul style="list-style-type: none"> Consider biomass filters for initial treatment to reduce carbon consumption Consider product removal only for initial phases followed by reinjection of "dirty" water



Green Remediation Appraisal

- Mass Reduction
- Carbon Footprint
- Water Footprint
- Cost benefit



Current options appraised



Four Original Options

- Option 1 – Pump and treat from shallow groundwater, Multiphase extraction from middle aquifer, with polishing by groundwater recirculation,
- Option 2 - containment wall and more limited extraction scheme
- Option 3 – PRB, with pump and treat from Shallow
- Option 4 – Ex-situ bio for shallow with MPV from middle

Agreed Option

Option 5 - Shallow soil washing, MPV from middle with Polishing by recirc, PRB

Green Remediation Option

Option 6 - Trenching for NAPL removal in shallow, NAPL extraction with flow path management and enhancements in middle

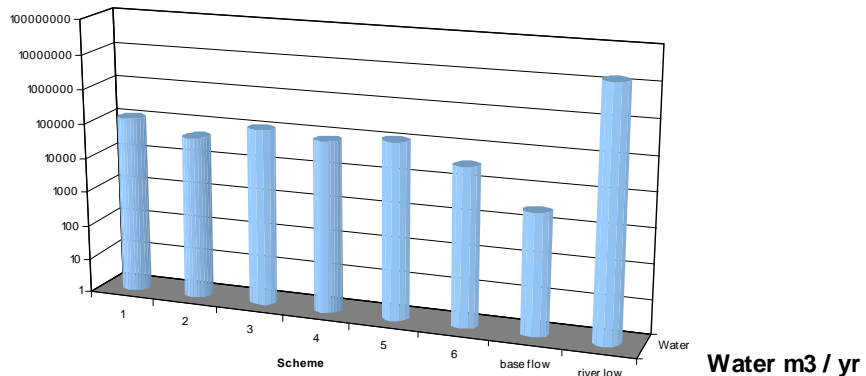


Mass reduction

scheme	1	2	3	4	5	6
mass reduction	51%	12%	69%	62%	64%	59%



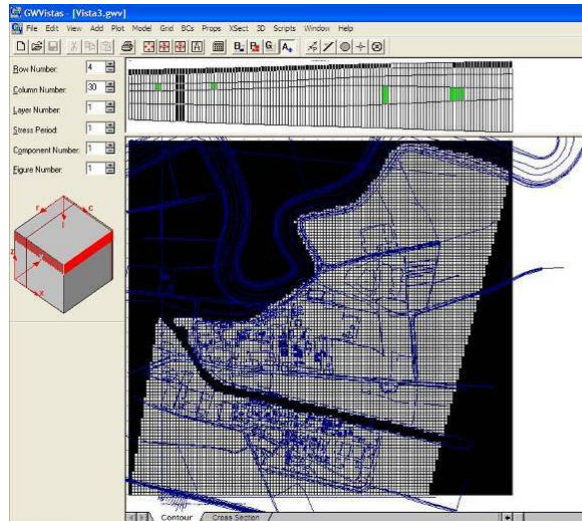
Initial Water Footprint Analysis



Water Footprinting Tools

Modflow 5 layer model

- Area of impact
- Effect on baseflow
- Containment
- optimisation

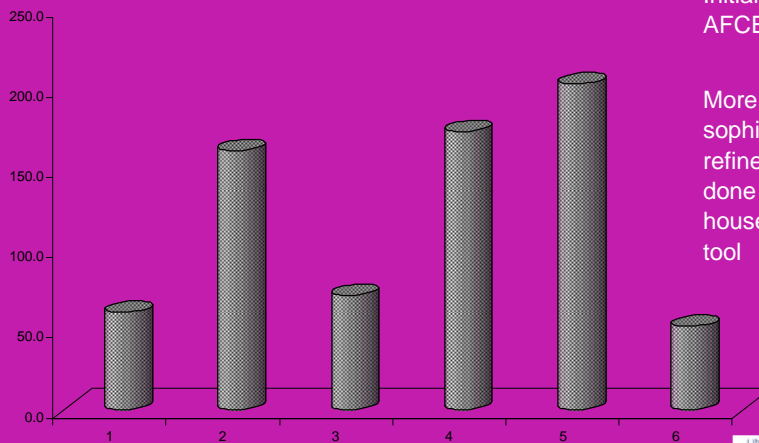


CO₂ (Tonnes)

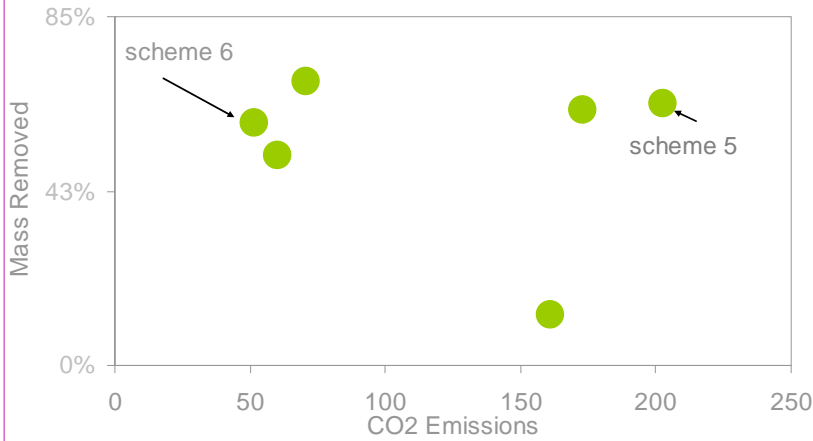
carbon

Initial assessment
AFCEE SRT tool

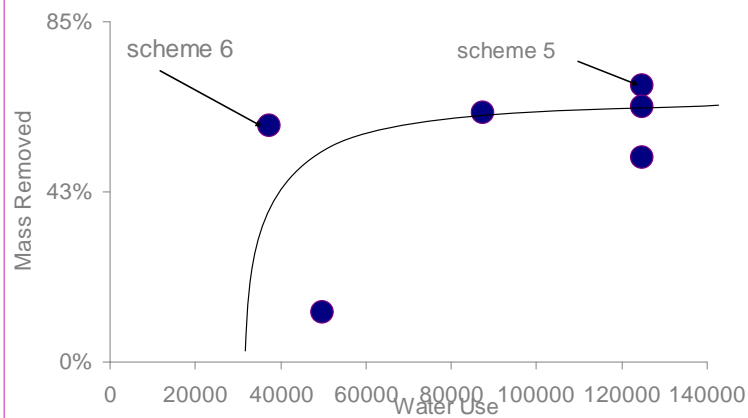
More sophisticated
refinements to be
done using in
house bespoke
tool



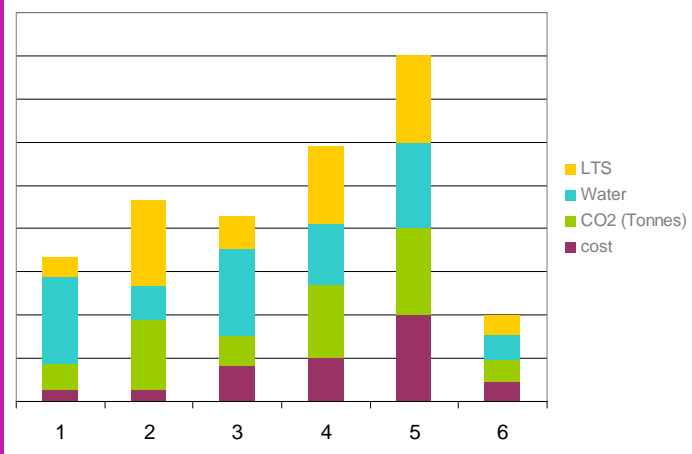
IMPACT VS BETTERMENT - CARBON



IMPACT VS BETTERMENT - WATER



TOTAL FOOTPRINT



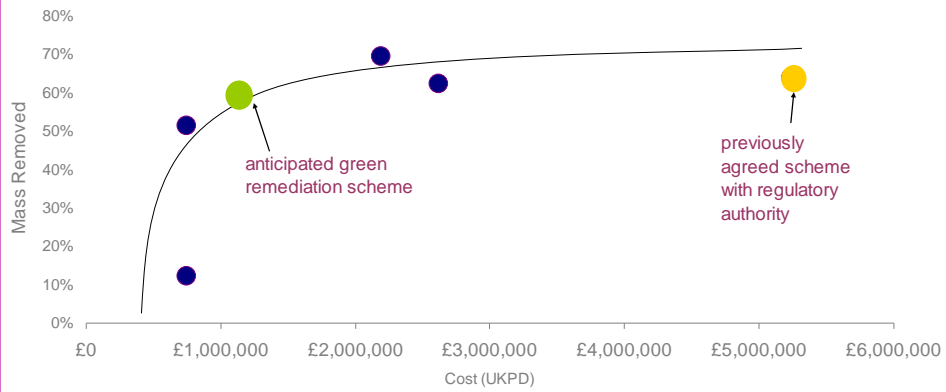
Greening the remediation so far



- Savings to water
- Savings in CO2
- Residual mass trade off....



COST BENEFIT



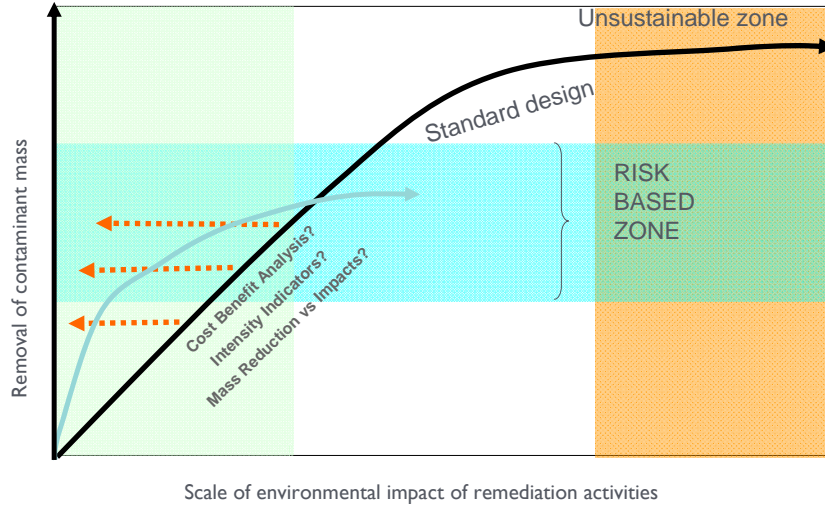
NEXT STEPS

Cell 1 implementing

- Mass recovery data
 - Modflow model
 - Carbon calculator
 - Cost benefit analysis
- Concentrate on improving option 6, and sharing data with regulator as we go



Further greening the remediation scheme



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Thank you
? Questions ?

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