Novel Composite Landfill Liners

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Chapter 2: Materials and mix characteristics

Chapter 3: Laboratory test methods

Chapter 4: Site trials

Chapter 5: The Coventry computer model

Chapter 6: Validation of Coventry University model.

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General description of barrier

- Current Barrier System: 30mm thick “Bentomat” geotextile with bentonite infill on 1 m of milled and compacted existing clay.
- Basic Design: 300mm concrete on 0.5 m of milled and compacted clay.
- Approximate area: One hectare.

The principal intended benefits of the new barrier

- Low permeability combined with high cation exchange capacity to give improved containment.
- Construction from waste materials which would otherwise go into landfills.
- A relatively hard concrete surface to permit operation of vehicles and to prevent damage from large items of waste compacted onto it.

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Candidate materials (1)

- Sodium sulphate slag (Britannia Refined Metals Ltd.)
- Spent borax slag (Britannia Refined Metals Ltd.)
- Ferrosilicate slag (lumps from Britannia Refined Metals Ltd. sand size from Britannia Zinc Ltd.)
- Ferrosilicate copper slag (IMI Refiners Ltd.)
- Soda slag (Britannia Refined Metals Ltd.)
- Chrome Alumina slag **(**London & Scandinavian Metallurgical Co. Ltd.)
- Cement Kiln Dust ,CKD (Rugby Cement)
- Run of station ash (Ash Resources Ltd.)
- Lagoon ash (UK quality Ash Association)
- PFA (Ash Resources Ltd.)
- Steel slag (Tarmac Quarry Products Ltd.)
- Granulated Blast Furnace Slag, GBS (Tarmac Quarry Products Ltd.)

Candidate materials (2)

- Burnt Oil Shale (Tarmac Quarry Products Ltd.)
- By-product Gypsum (Biffa Waste Services Ltd.)
- Glass cullet (Mercury Recycling Ltd.)
- GGBS (Ground granulated blastfurnace slag)
- Limex70 (British Sugar Plc.)
- Shell foundry sand (Bruhl UK Ltd., Hepworth Minerals & Chemicals Ltd.)
- Green foundry sand (Castings Plc. And Bruhl UK Ltd.)
- Fire kettle setting (Britannia Refined Metals Ltd.)
- Fine rotary fascia bricks (Britannia Refined Metals Ltd.)
- Sodium sulphate solution (Britannia Refined Metals Ltd.)

Candidate Mix Design

Material	Kg/m3	Total quantity Tonnes
Cement Kiln Dust	150	450
Steel slag Dust (0-5mm)	700	2100
Conditioned ash	150	450
Shell sand	700	2100

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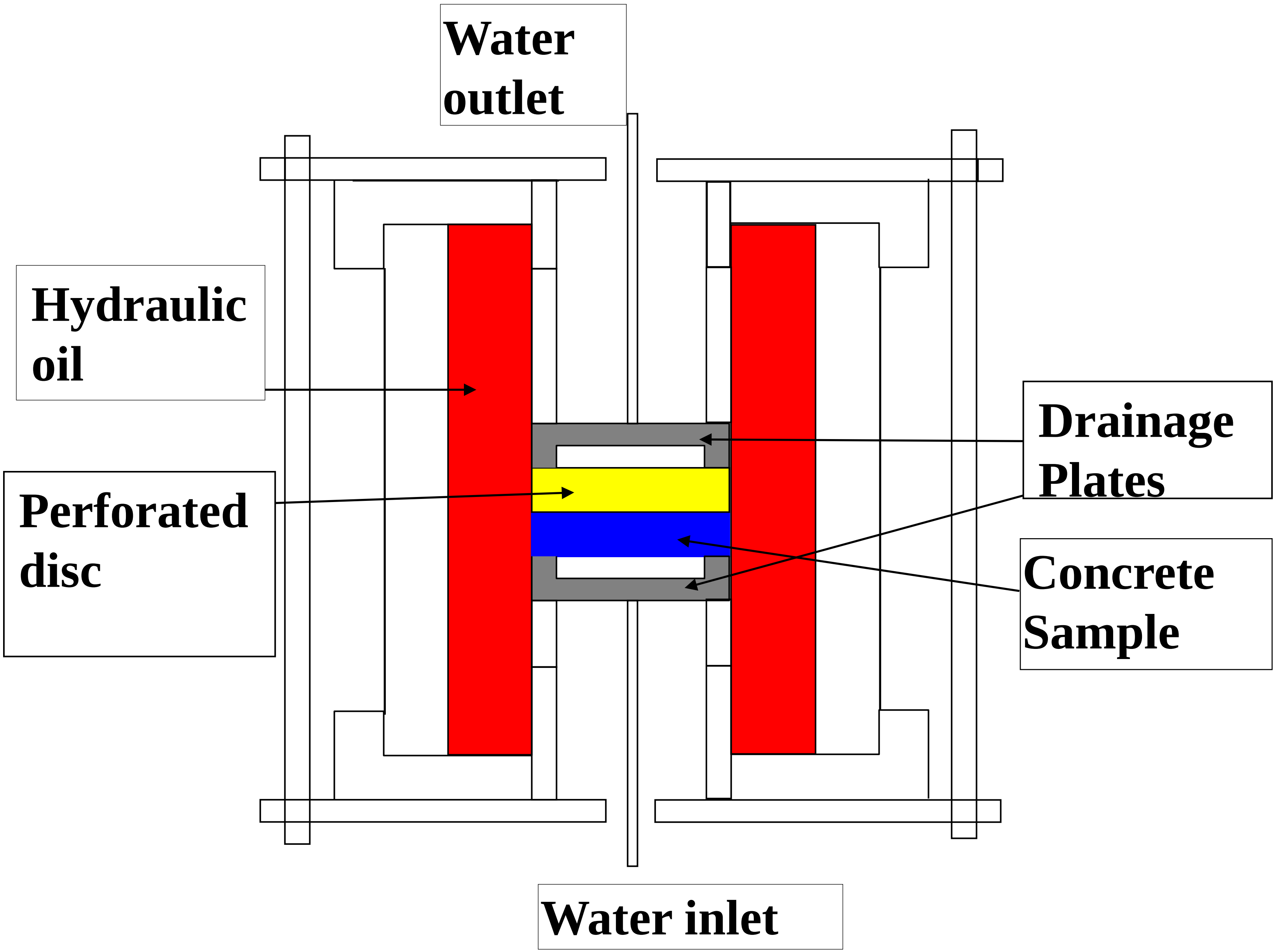

The High Pressure Through Flow Cell

High pressure permeability measurement

Narrow cracks induced in the mortar disc

Composite clay and concrete sample for high pressure test

Cracked sample after clay has sealed the cracks

The Diffusion Cells

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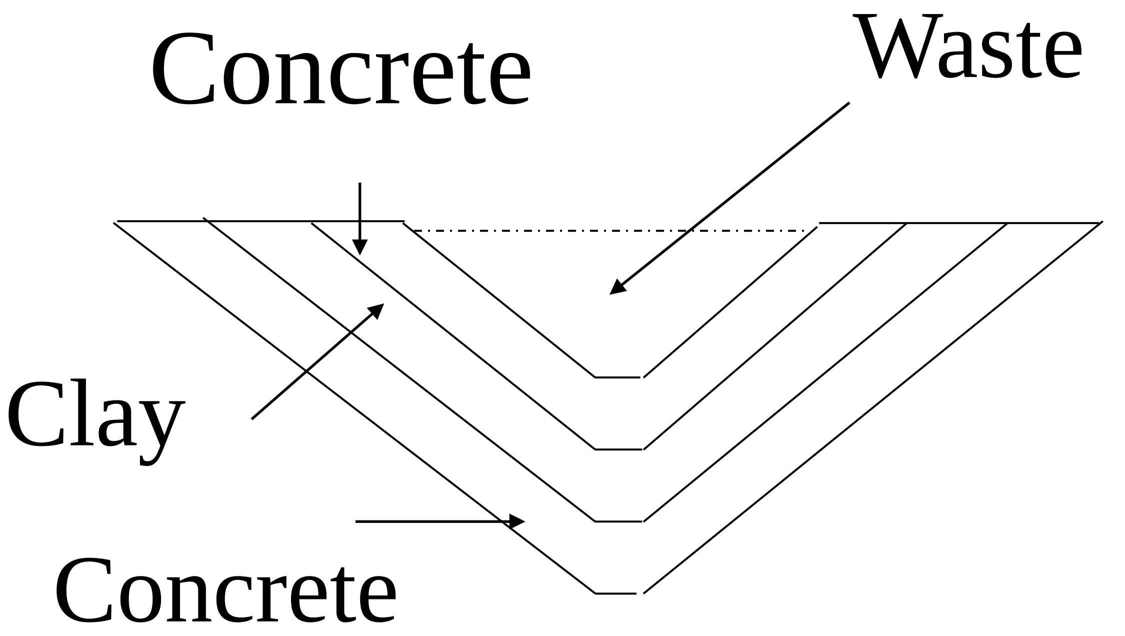
The Site Trial Cells



Liquid waste (sodium sulphate)

Concrete in cell 1

Filled cell ready for cover

Sampling lines

The purpose of the trial cells

- To provide validation data for the modelling of the performance of the barriers in service.
- To demonstrate a construction method.
- To demonstrate that the novel mixes can be made in industrial quantities (150t of concrete was used in the three test cells).
- To provided samples for on-site workability testing and long-term physical testing in the lab.
- To provide samples for mineralogical analysis when the cells are dismantled.

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Mechanisms used in calculation

- Advection in which the pressure of the leachate head causes water flow which carries dissolved ions through.
- Diffusion in which the dissolved ions move through the water at a rate determined by the pressure gradient.
- Linear adsorption in which a fixed proportion of the dissolved species are assumed to be immobile

Applications of the model

- The high pressure through-flow test
- The diffusion test
- The “8m” site trial cells at Risley
- The “100m” barrier to be built at Poplars

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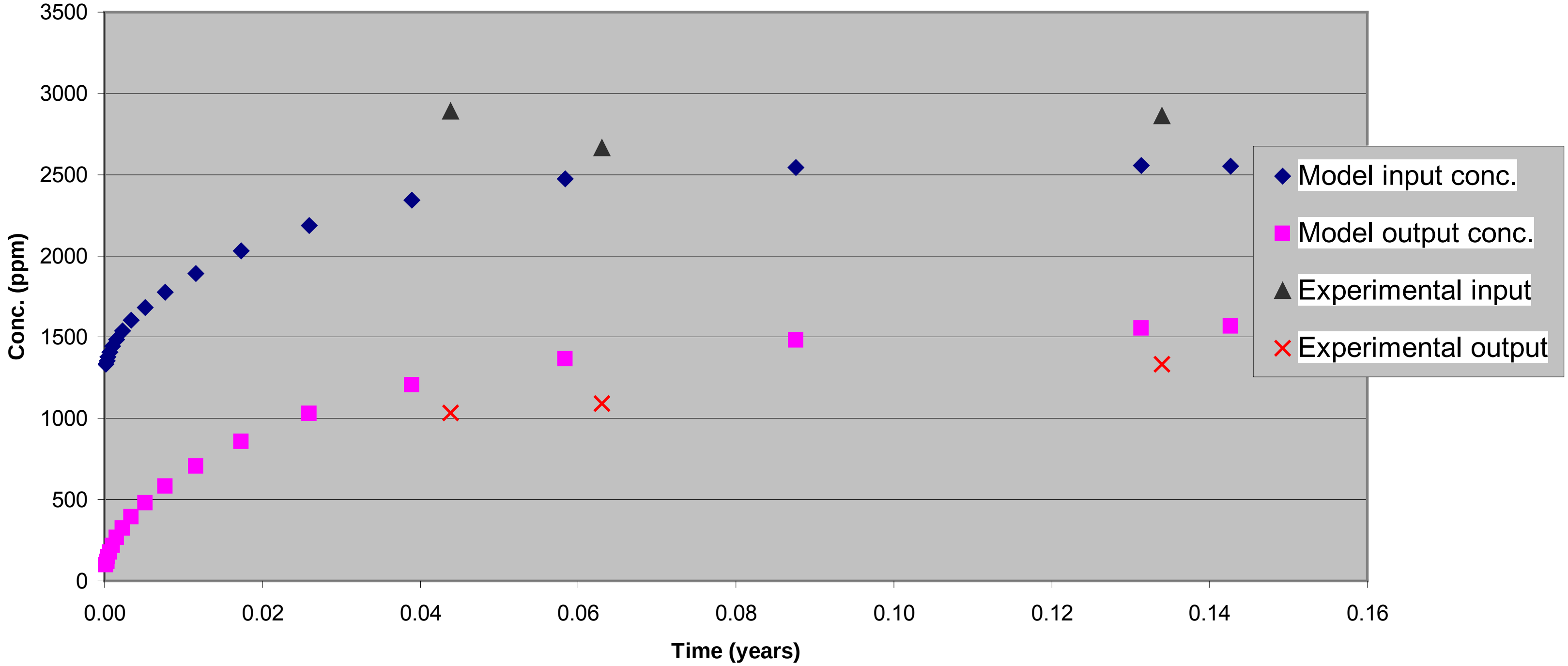
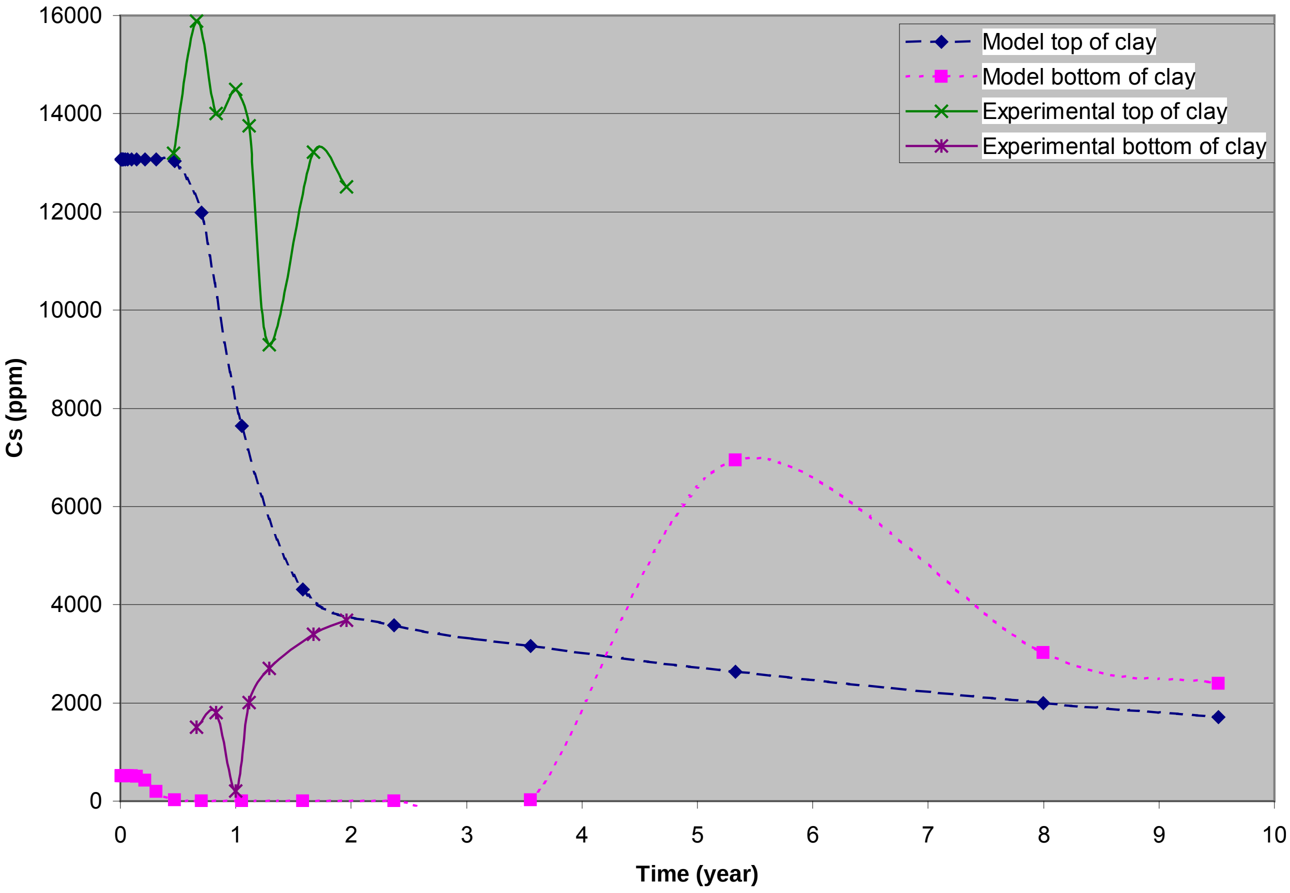
Results from laboratory diffusion test

Fig. 6.4: Modelled 'K' concentration Vs. time in Diffusion cell for top layer mix of site cell 2 &3.



Result from site trial

Fig. 6.11 : Modelled and experimental 'K' concentration Vs. time at different levels in site trial cell no. 2.



Locations for the barrier

- Horizontal: Failure by compression or punching shear.
- 30 degree slope: Compression and buckling
- Vertical: Compression and buckling

30 degree slope

- Slope length of 50m is considered giving a depth of 25m
- Before emplacement of waste: Assuming no friction with the substrate gives a stress of 0.57 MPa in the concrete.
- Waste emplaced: Assuming no slippage of the waste above the liner (very high friction) and the shear strength of the clay under the liner is 50 kPa gives a stress of 5MPa in the concrete.

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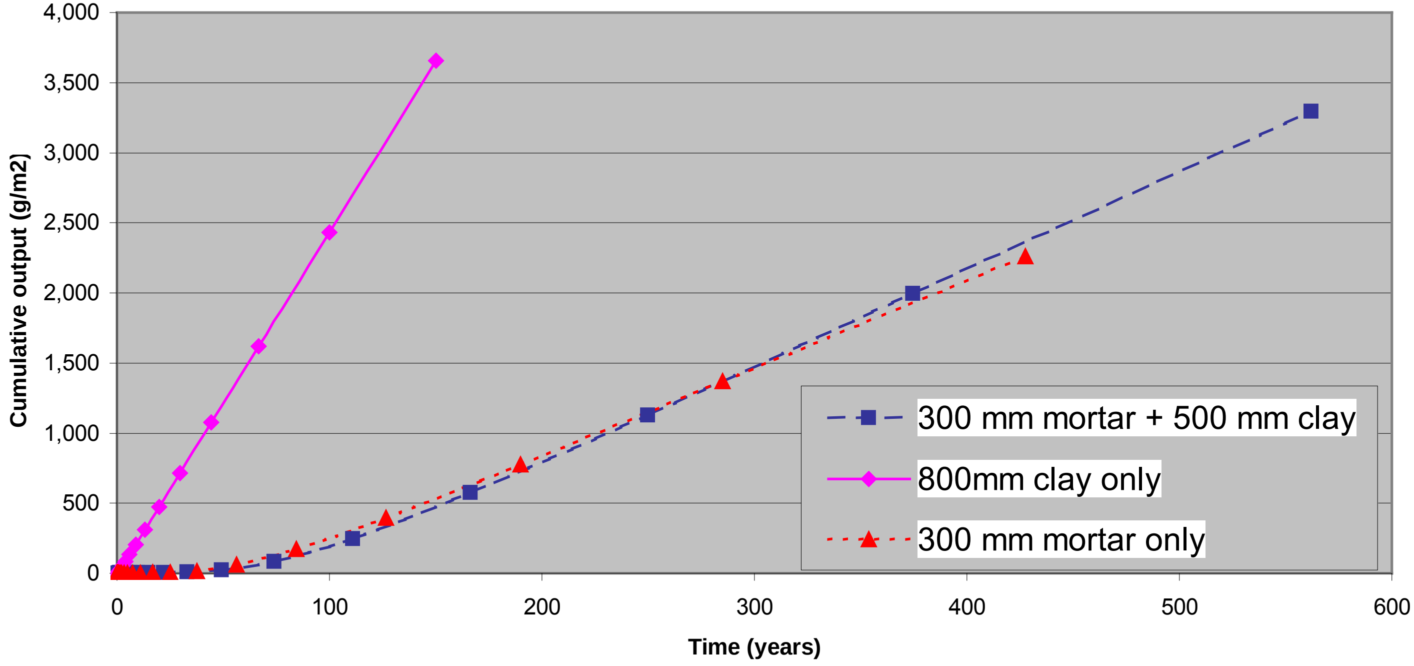
Use of CU model

- Uses results from lab tests for diffusion and permeability
- Validation from Risley trials
- Uses linear adsorption isotherm.
- Models 300mm concrete on 500mm clay

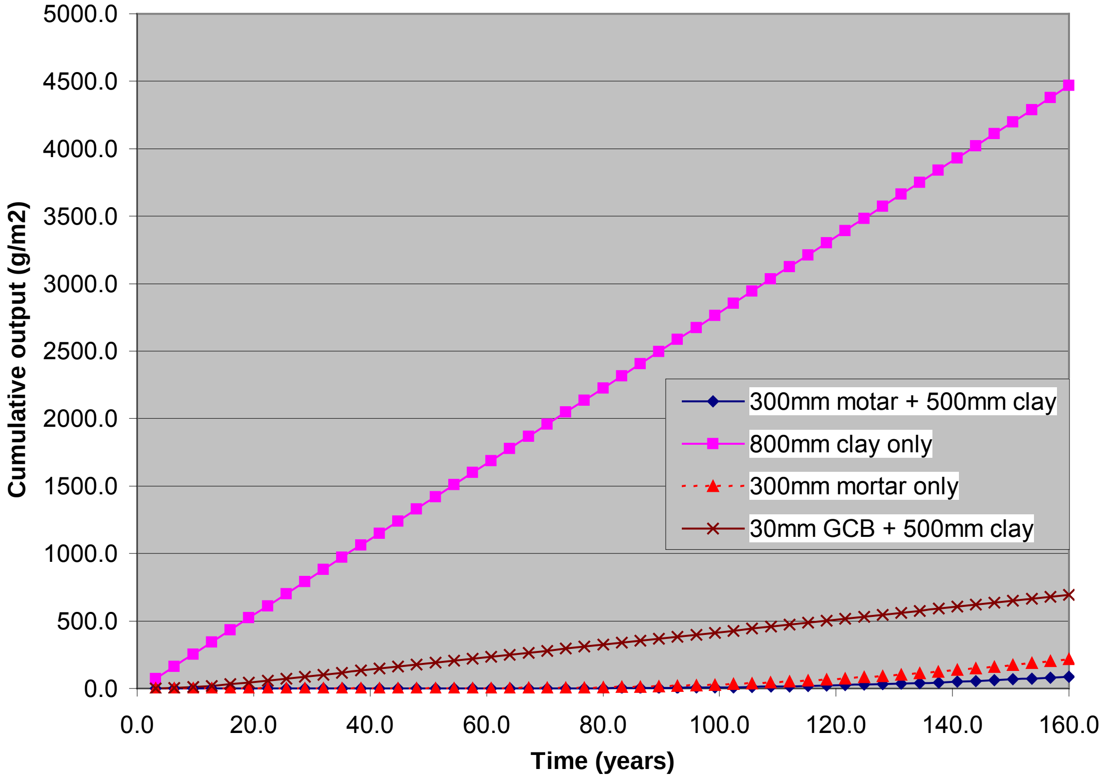
Output from CU model

Fig. 9.1 : Modelled 'Ca' concentrations for multi layer and clay only barriers using site leachate.

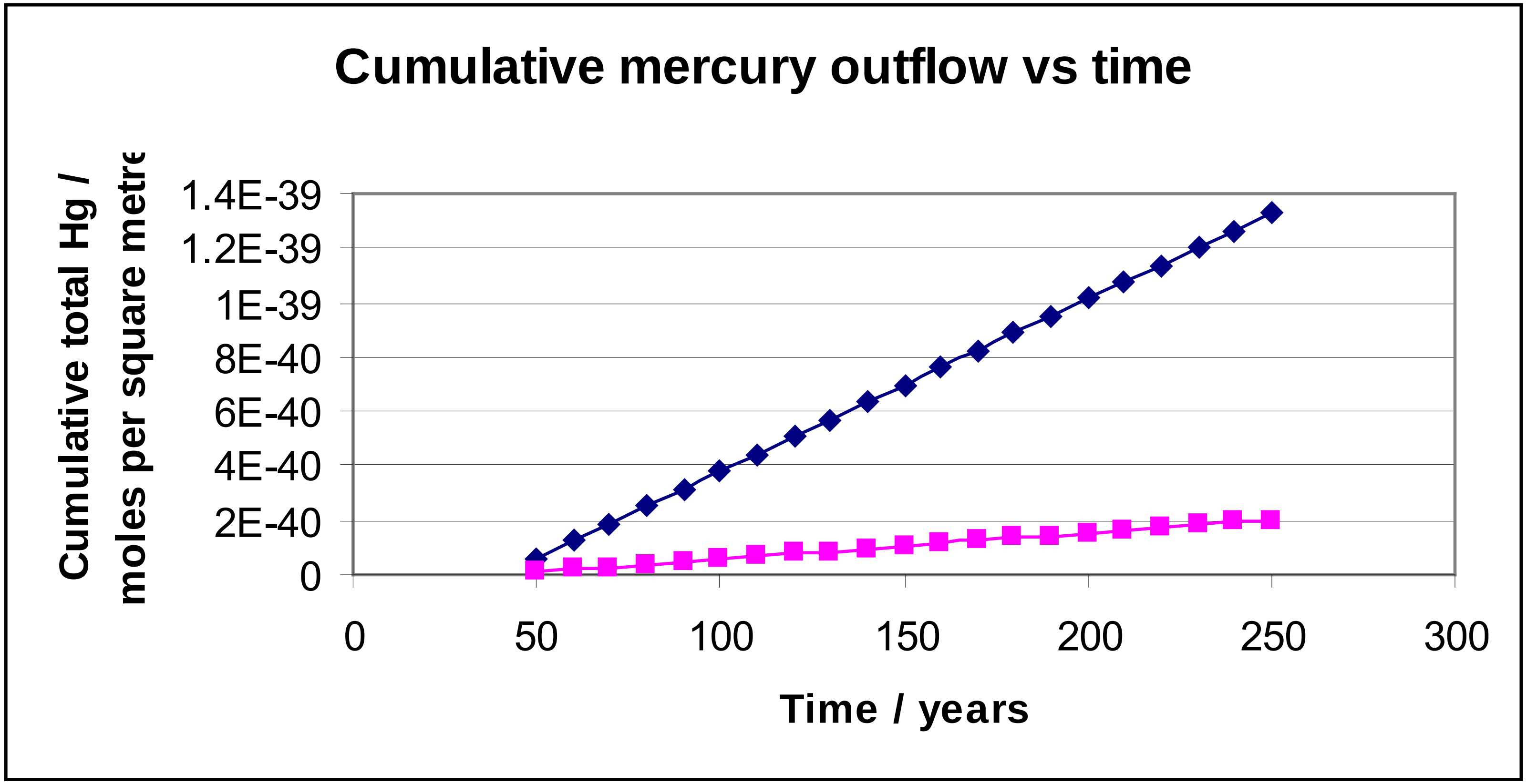


Output from CU model

Fig. 9.6: Modelled 'Pb' concentrations for multi-layer and clay only barriers using toxic leachate.



Output from PHREEQE model



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Quality Assurance of the Barrier

- Generally follow the quality procedure for the geosynthetic barrier system.
- Concrete cubes shall be made to EN12390 part 1
- Permeability may be measured to EN12390 part 8 if accompanied by an approved method of calculation to yield results in m/s or other approved method.

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Work plan

- Respond to input from the EA
- Refine the input data to the Coventry model to provide a better explanation of the 8m trial cells and use this data to improve the modelling of the 100m cell.
- Extend the application of PHREEQE to provide increased experimental validation.