In-situ Flushing of Petroleum Contaminated Soil

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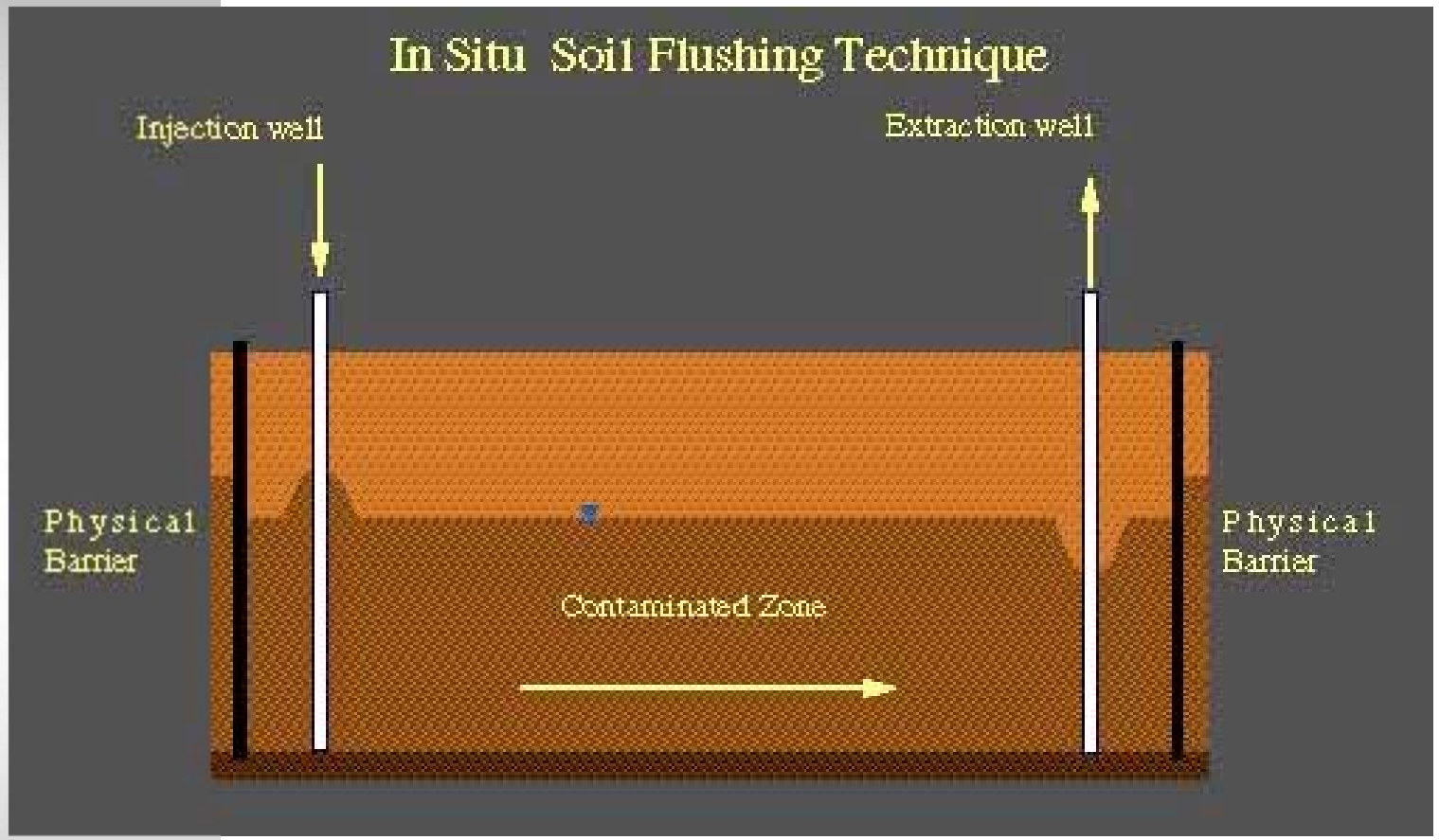
Scope of the presentation

- ✓ Principle of in-situ flushing
- ✓ Lignin derivatives as prospective flushing agents
- ✓ Work objectives
- ✓ Experimental setup
- ✓ Results and discussions
  - Petroleum hydrocarbons
  - Heavy metals
- ✓ Conclusions and recommendations

Principle of the process

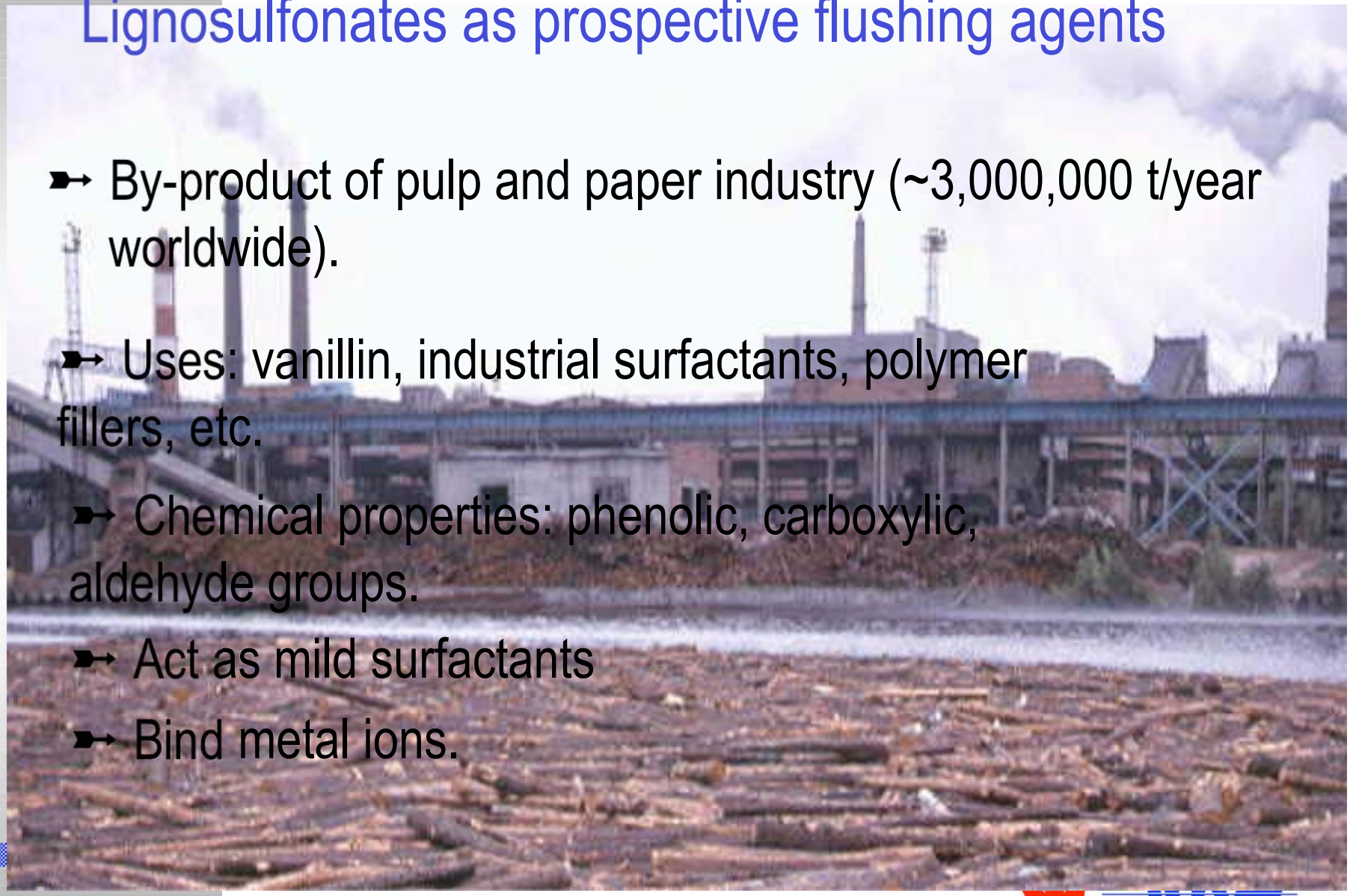


Source: P.Benchimol, M.Pandit "Remediation of Contaminated Soils…" Civil Eng. Dept., Virginia Tech, 1998

Main features of in-situ flushing

- ✓ Lower costs associated with in-situ treatment (no soil excavation/ building demolition required)
- ✓ Minimal interruption of commercial/industrial activities at the site
- ✓ Treatment rates are generally slower than for ex-situ treatment
- ✓ “Open” treatment system

Lignosulfonates as prospective flushing agents



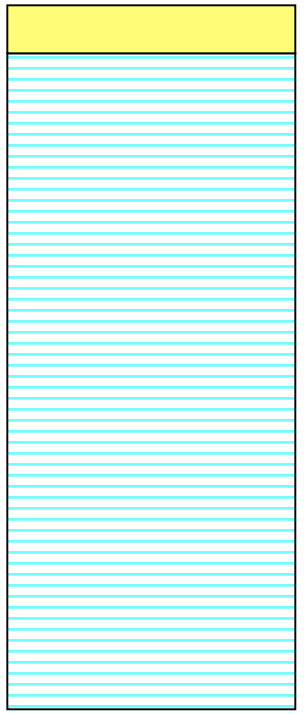
- By-product of pulp and paper industry (~3,000,000 t/year worldwide).
- Uses: vanillin, industrial surfactants, polymer fillers, etc.
- Chemical properties: phenolic, carboxylic, aldehyde groups.
- Act as mild surfactants
- Bind metal ions.

Work objectives

- ✓ Bench-scale study
  - ➢ To evaluate commercially available lignosulfonates as flushing agents in in-situ treatment of petroleum contaminated soils
- ✓ In case of a successful treatment
  - ➢ Provide recommendations for for a pilot-scale study

Experimental setup

- ✓ Phase I – aqueous solubility tests
- ✓ Oil added to 100 ml of water or LS solution
- ✓ Parameters under evaluation: type and concentration of LS, pH, and contact time



Experimental setup

- ✓ Phase II – slurry leaching
- ✓ 100-200 g samples of contaminated soil (spiked and actual)
- ✓ Parameters under evaluation: type and concentration of LS, pH, and contact time

Experimental setup

- ✓ Phase III – column leaching
- ✓ 1,000-1,500 g samples of contaminated soil
- ✓ Parameters under evaluation: volume and concentration of flushing solution, pressure, and contact time

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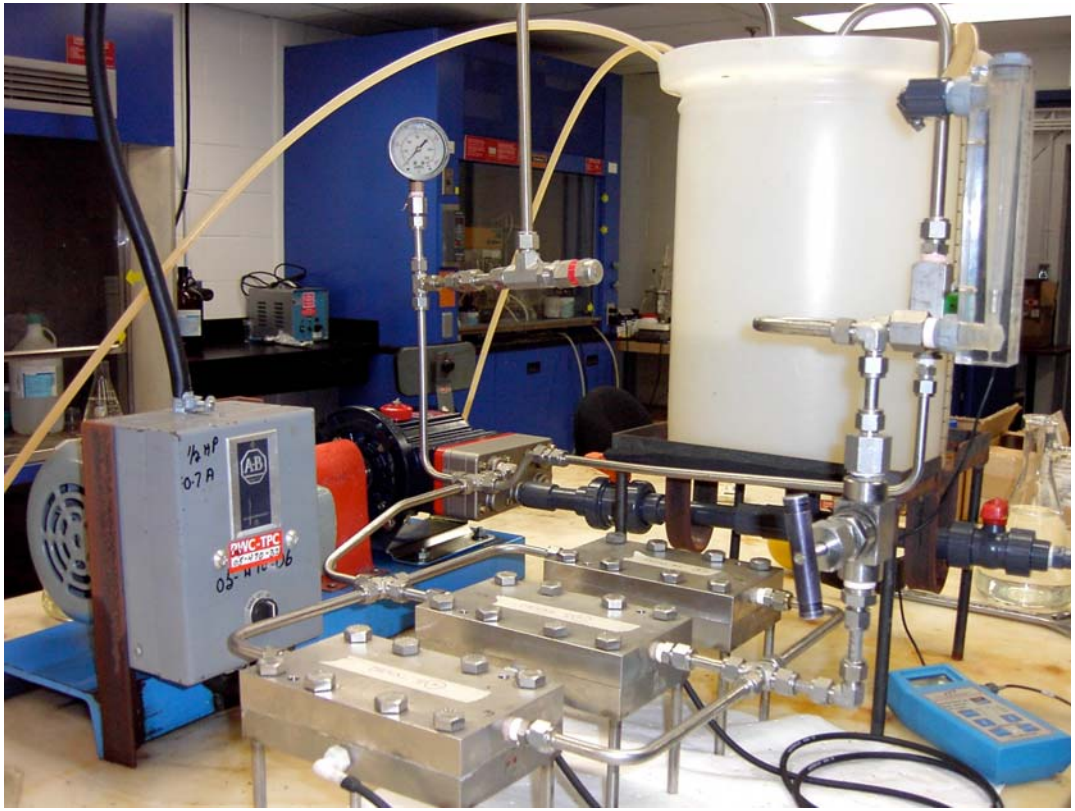
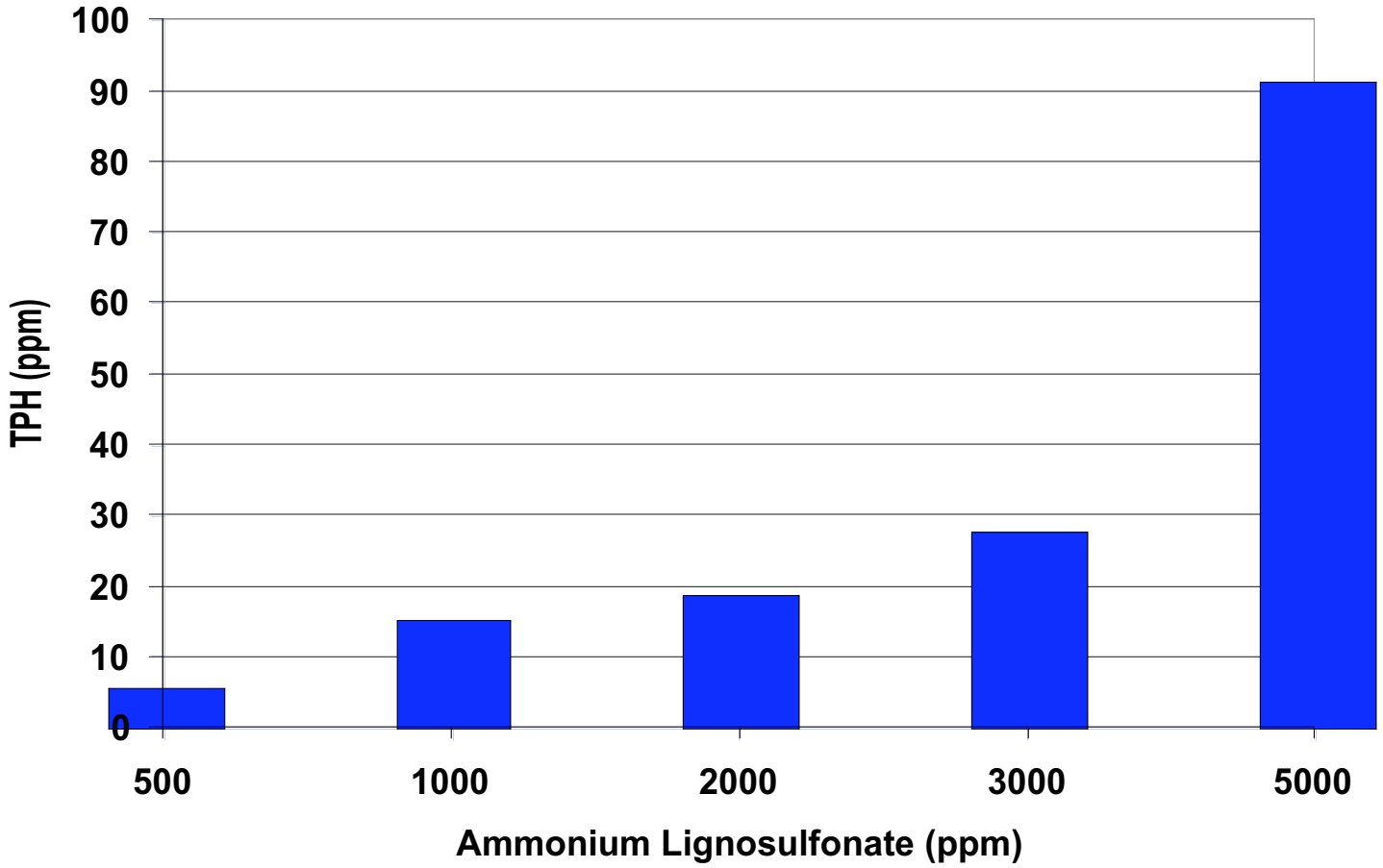
Experimental setup

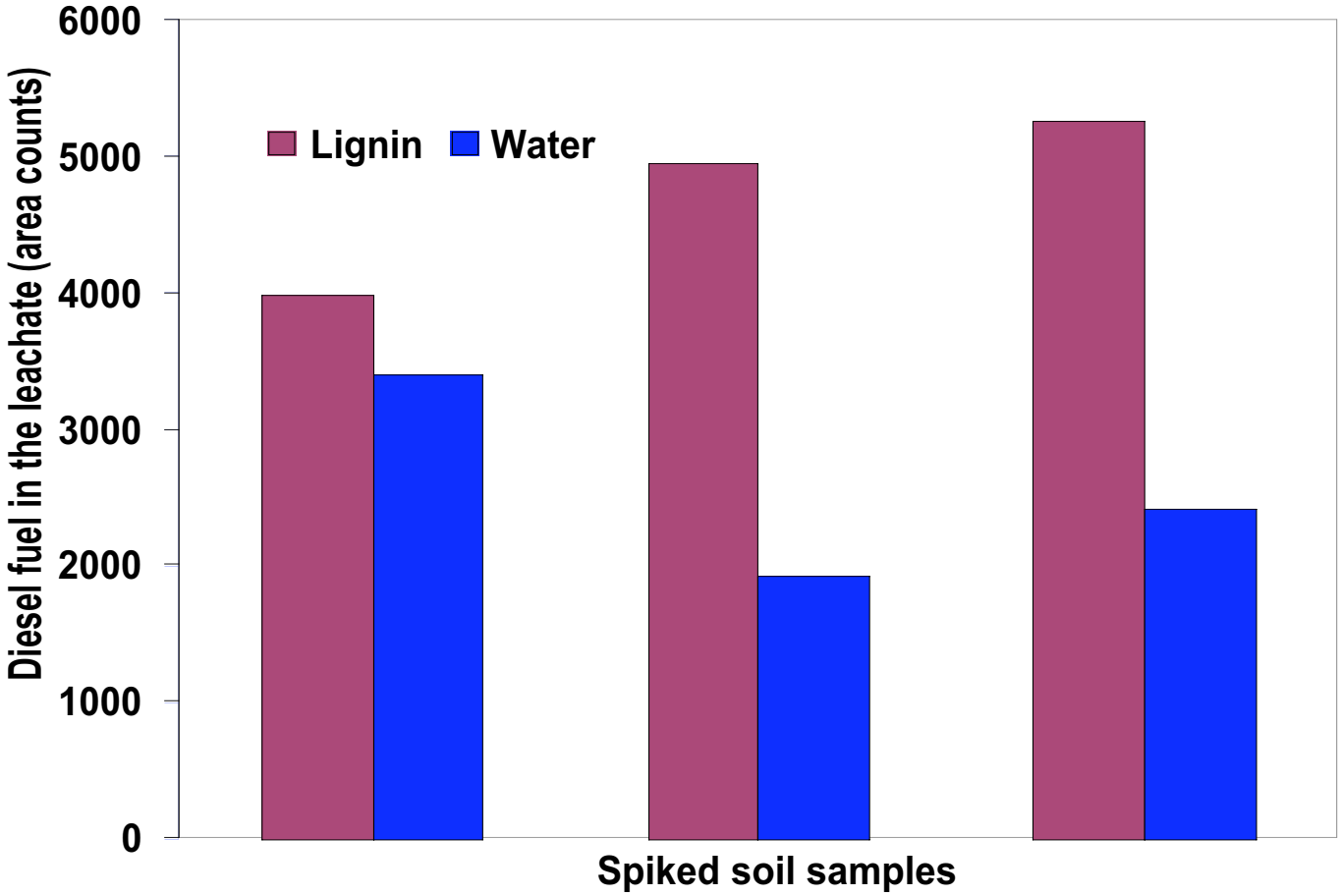
- ✓ Phase IV – leachate treatment
- ✓ Membrane filtration used to concentrate contaminates and reduce the leachate volume



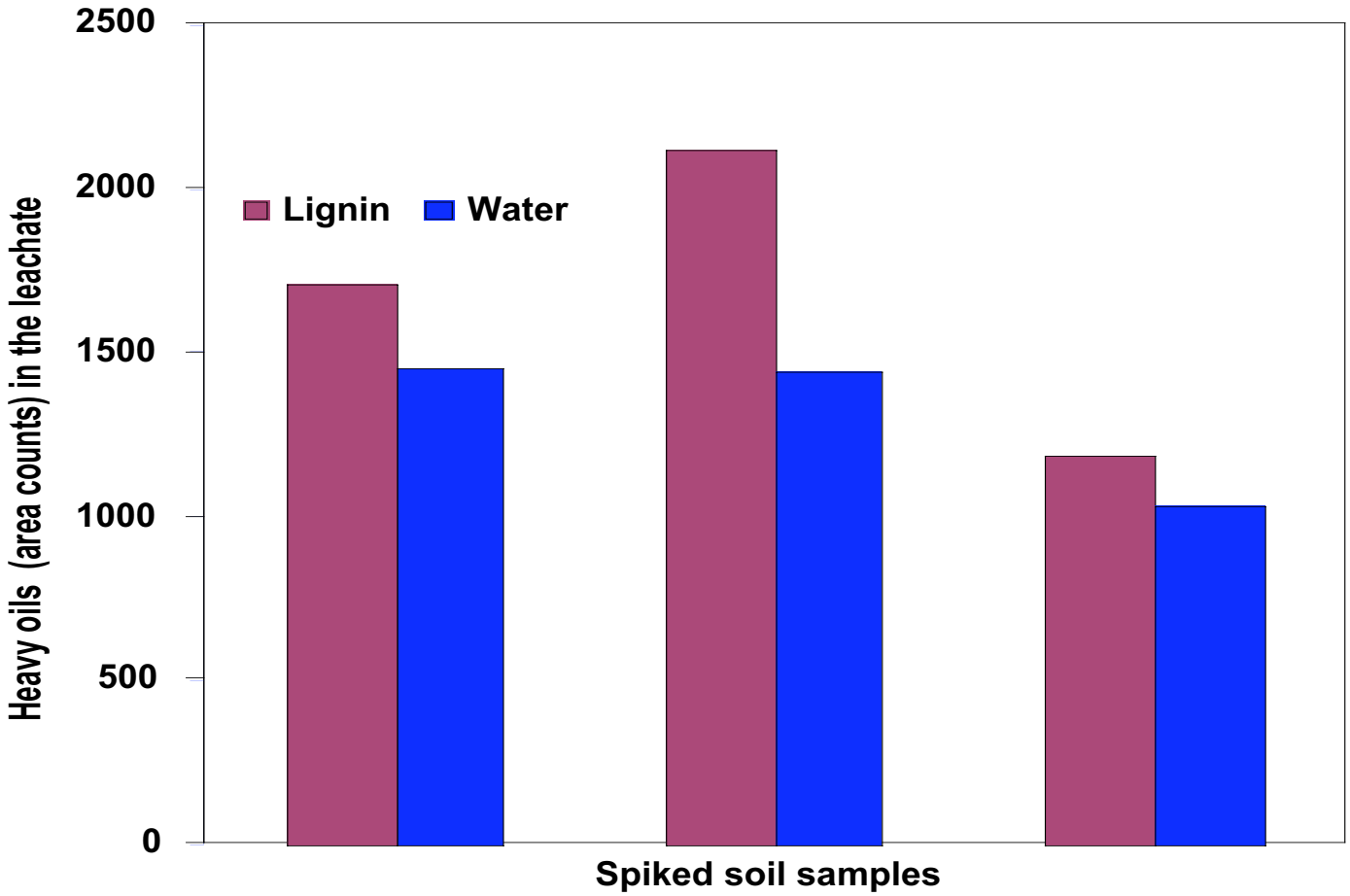
Test results: The effect of lignosulfonate concentration on the solubility of petroleum hydrocarbons



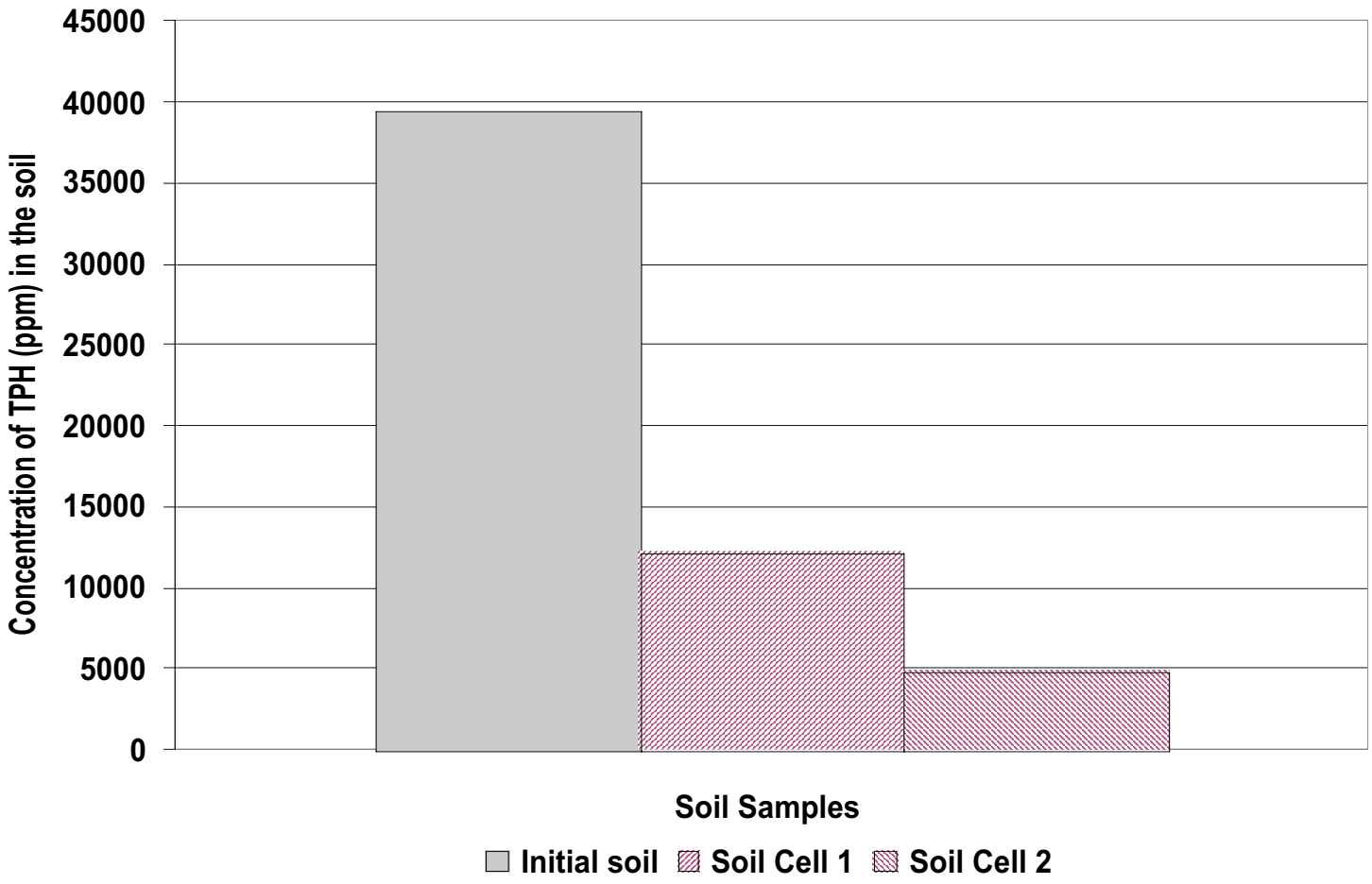
Results of slurry leaching: Diesel fuel



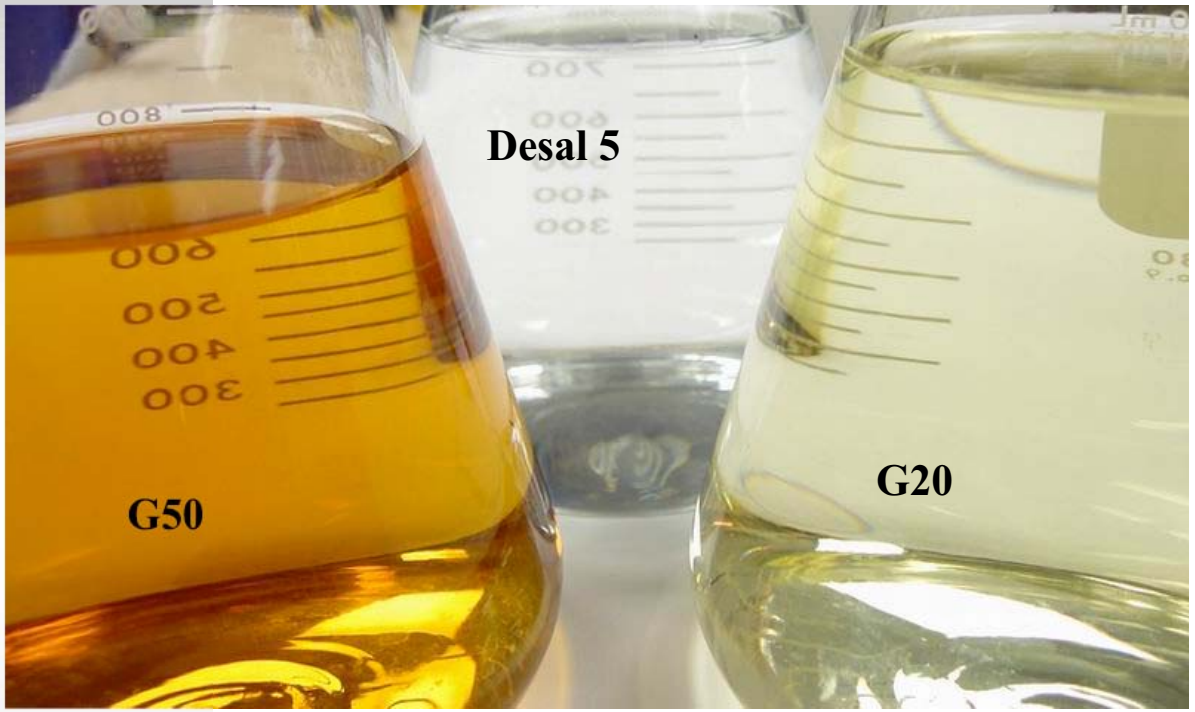
Results of slurry leaching: Heavy oils



Results of column leaching: Total petroleum hydrocarbons



Test results: Leachate treatment



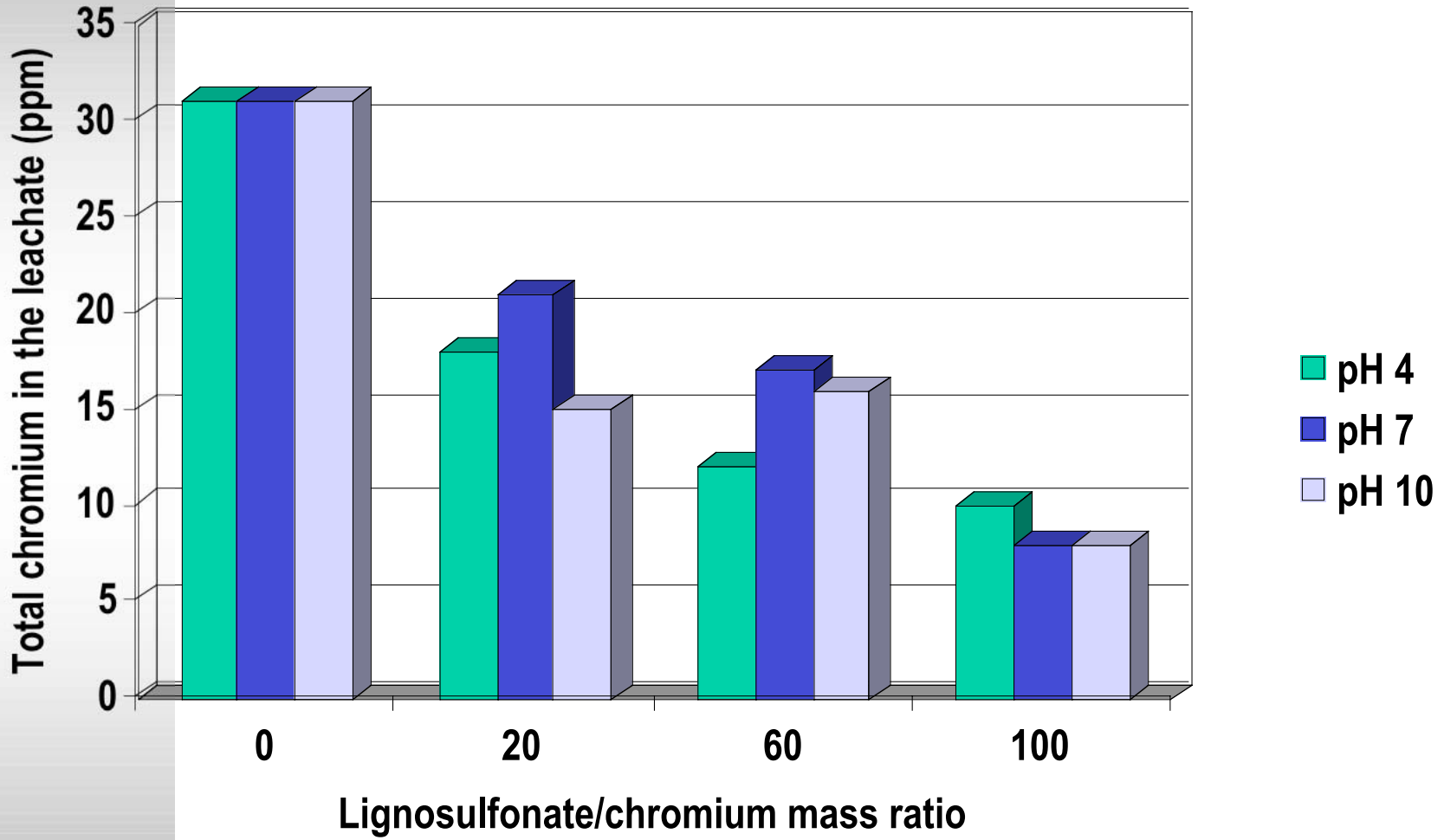
- ✓ Permeates generated using semi-permeable membranes Desal-5, G50 and G20 (all of GE Osmonics)
- ✓ Concentrate is biodegradable

Removal of heavy metals

Contaminants*	Percentage removal	
	"conventional"process	with lignin derivatives
Hg	0%	15%
U	0%	42%
Cd	26%	70%
Cr (III)	0%	24%
Pb	29%	75%

* Initial concentrations: 500 mg/L

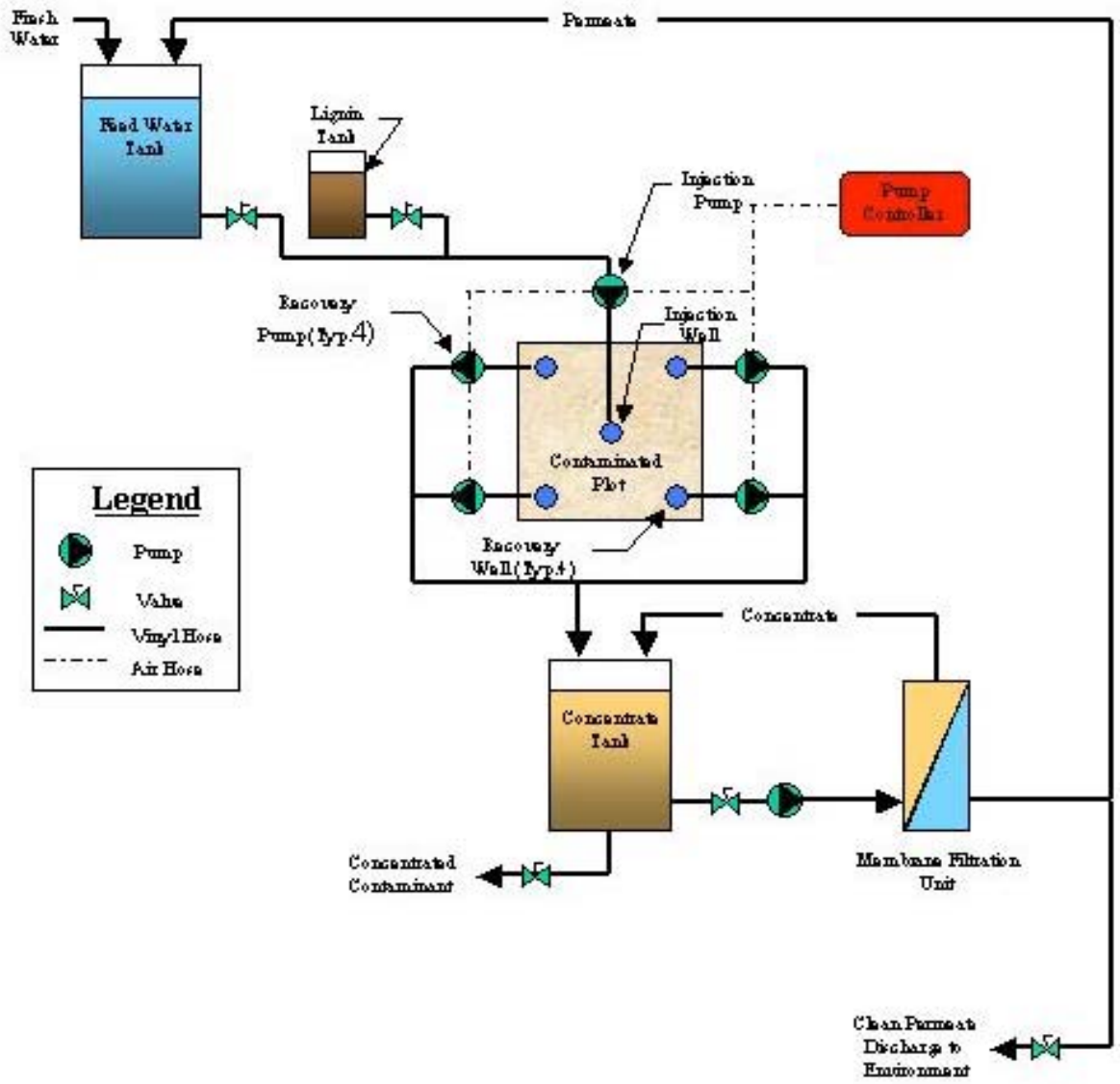
Stabilization of hexavalent chromium



Conclusions and recommendations

- ✓ Lignosulfonates enhance the removal of petroleum hydrocarbons from soil in in in-situ flushing
- ✓ Ammonium lignosulfonate is the most effective agent
- ✓ Leachate can be concentrated using membrane filtration
- ✓ Heavy metal removal observed. Possibility for the treatment of mixed contaminated soil
- ✓ Stabilization of hexavalent chromium in the soil observed
- ✓ Pilot-scale trial is recommended

Flow chart of the proposed pilot test system



Cross section of the treatment zone