

Impacts of Low Permeability Caps on Groundwater Quality

By

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Alan Environmental, LLC

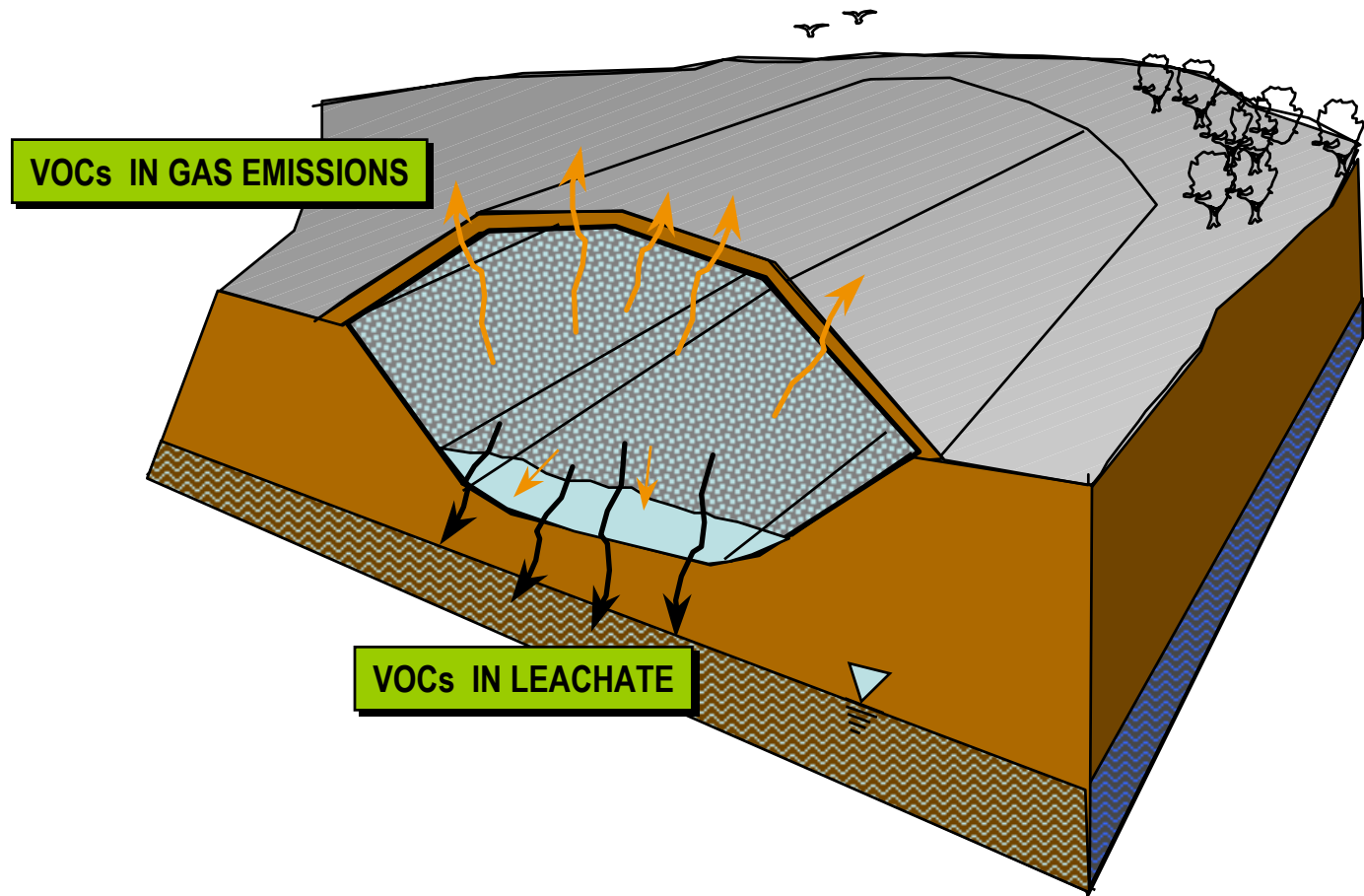
Acknowledgements

- Ken Quinn- Montgomery Watson, Madison Wisconsin
- Mark Ankeny-DB Stephens & Associates (presently with INEL)

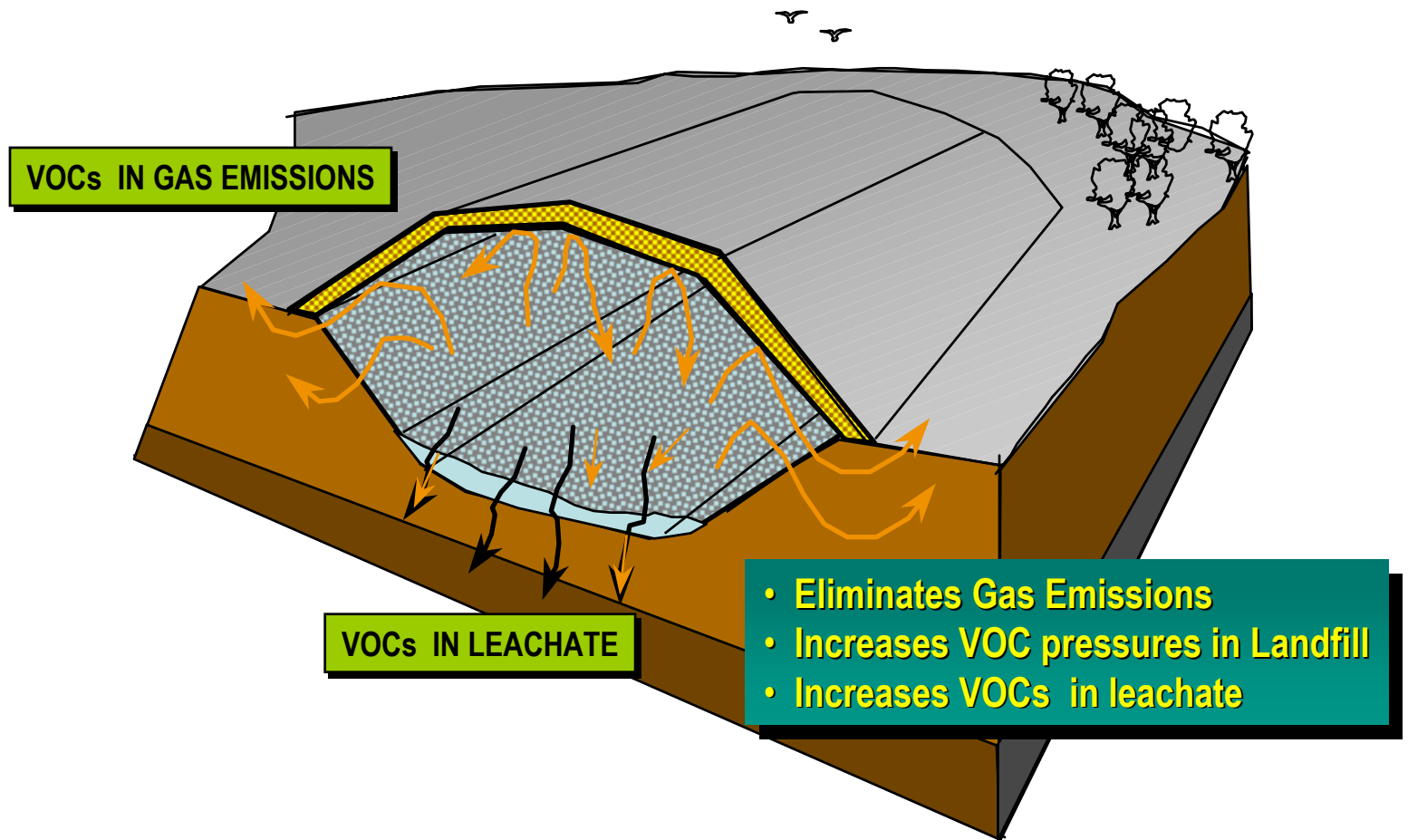
RCRA Cap Assumptions

- Purpose of RCRA cap is to minimize leachate production and prevent groundwater contamination
- For contaminated sites, purpose of RCRA cap is to improve groundwater quality
- In some site specific settings , the intended affect is not observed for RCRA caps or for low permeability soil caps.

Unlined Landfill Before Capping

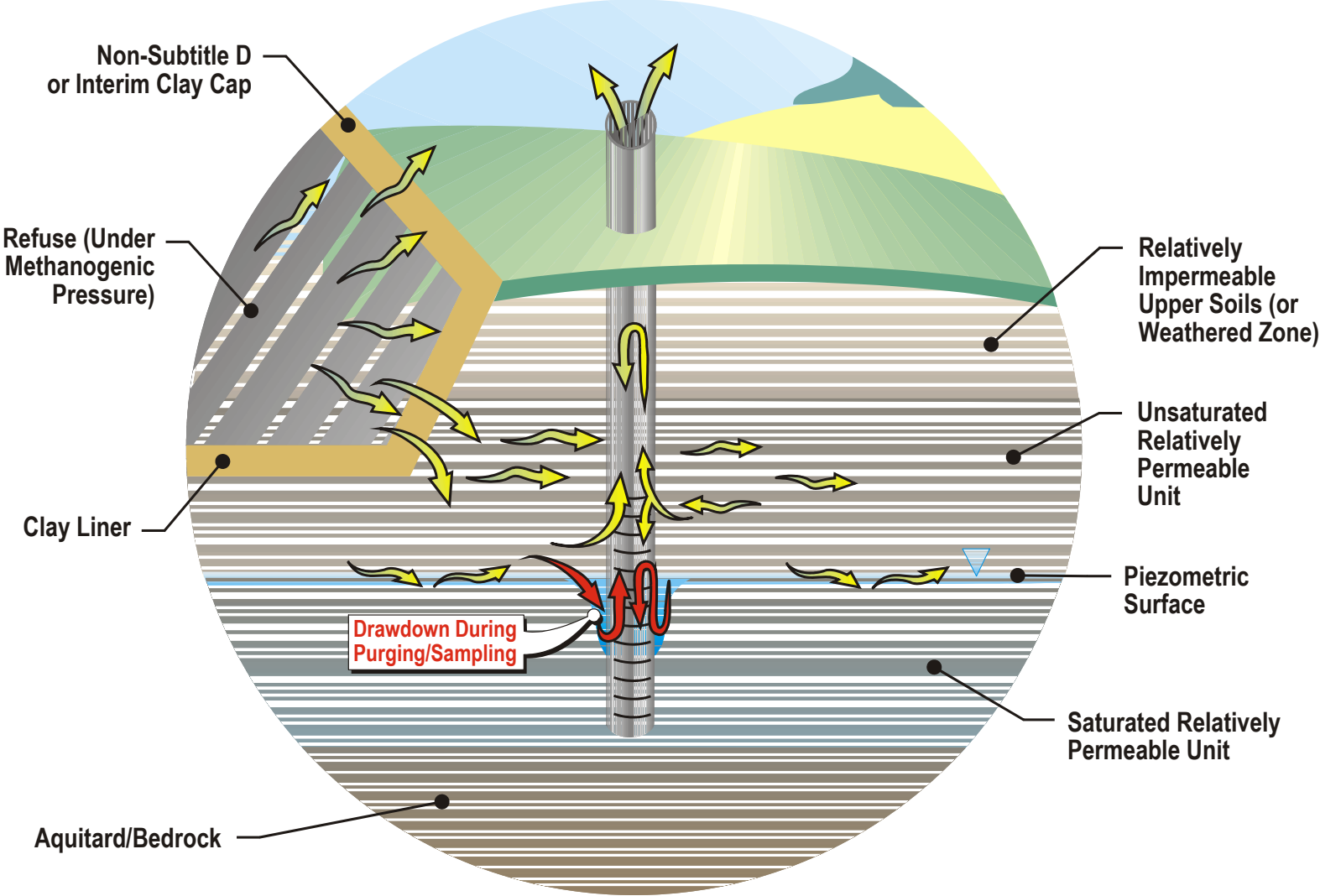


Capped Landfill

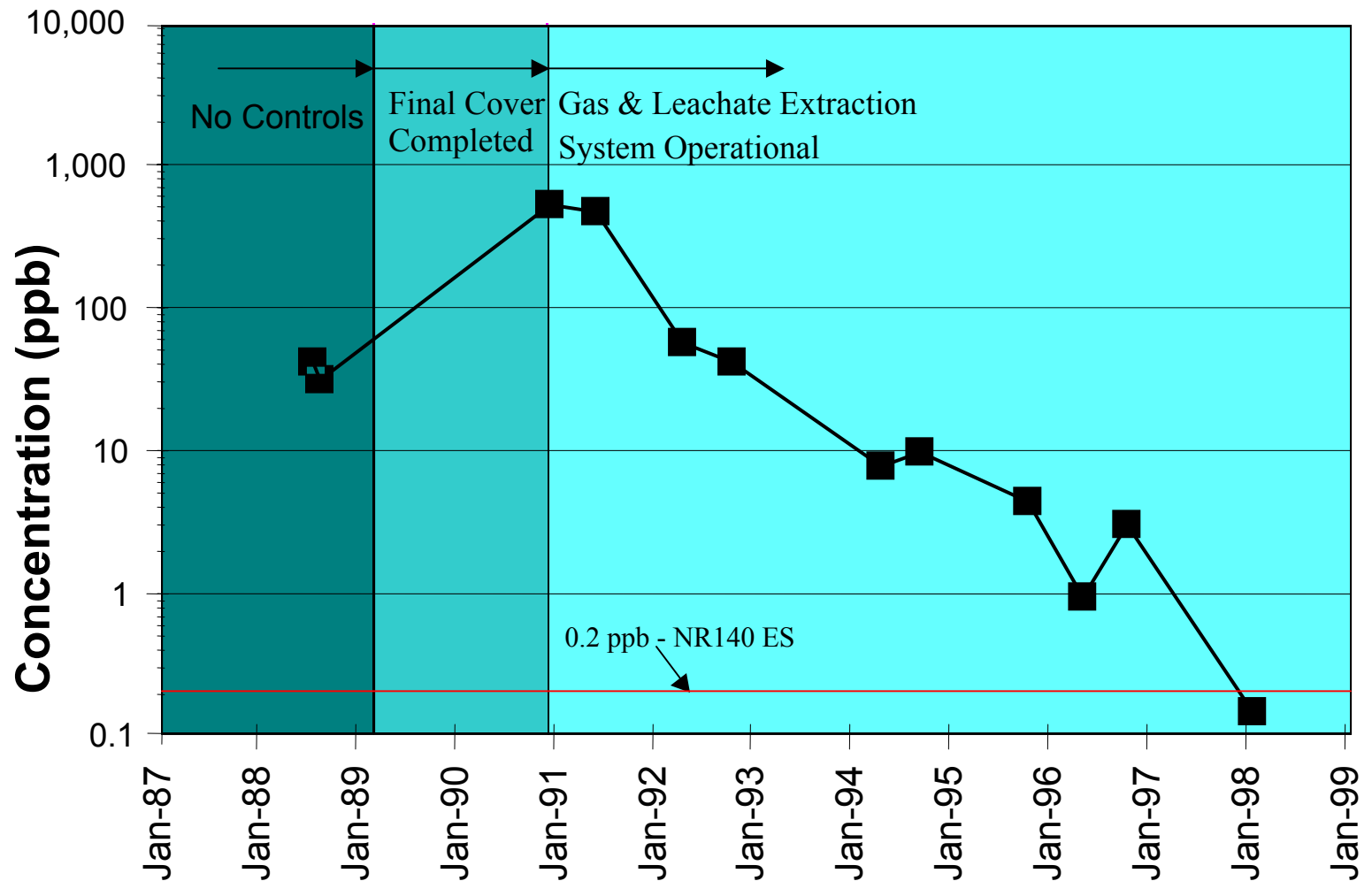


Mechanism of Transport

Landfill Gas Migration Conceptual Model

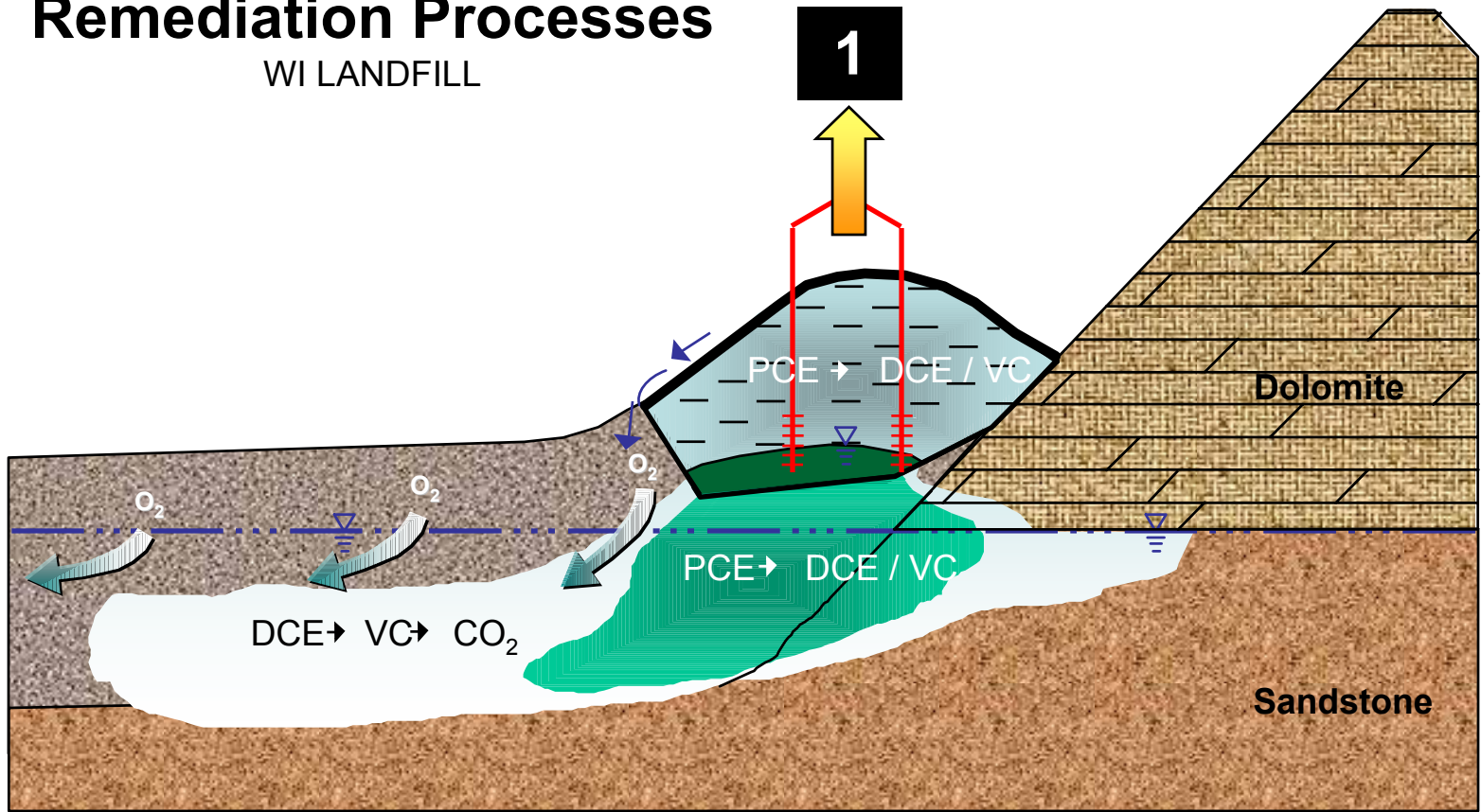


Montgomery Watson Study of WI Landfill Vinyl Chloride Through Time



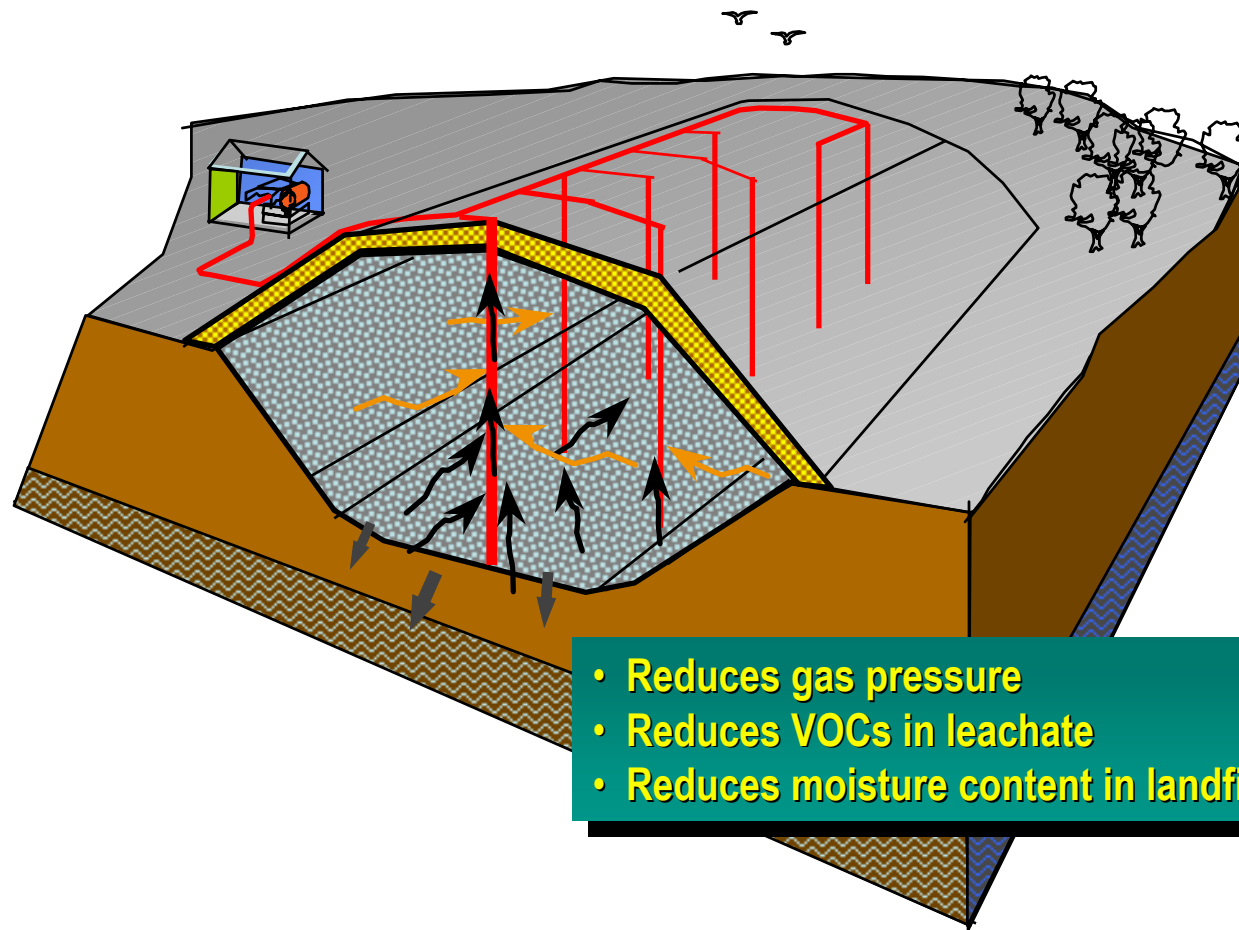
Remediation Processes

WI LANDFILL



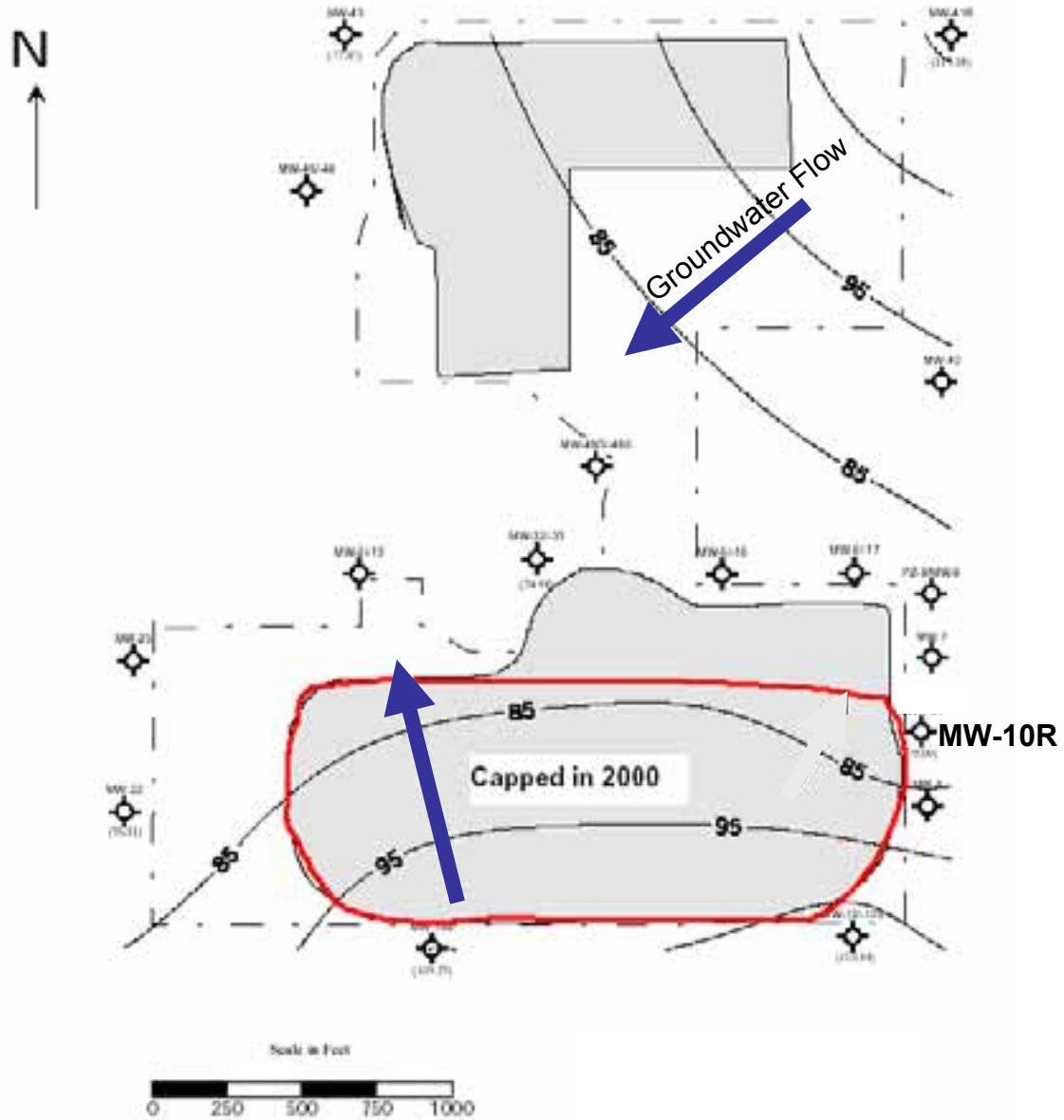
1	Extraction		Removal of VOCs in Vapor and Liquids
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Capped Landfill with Leachate and Gas Extraction

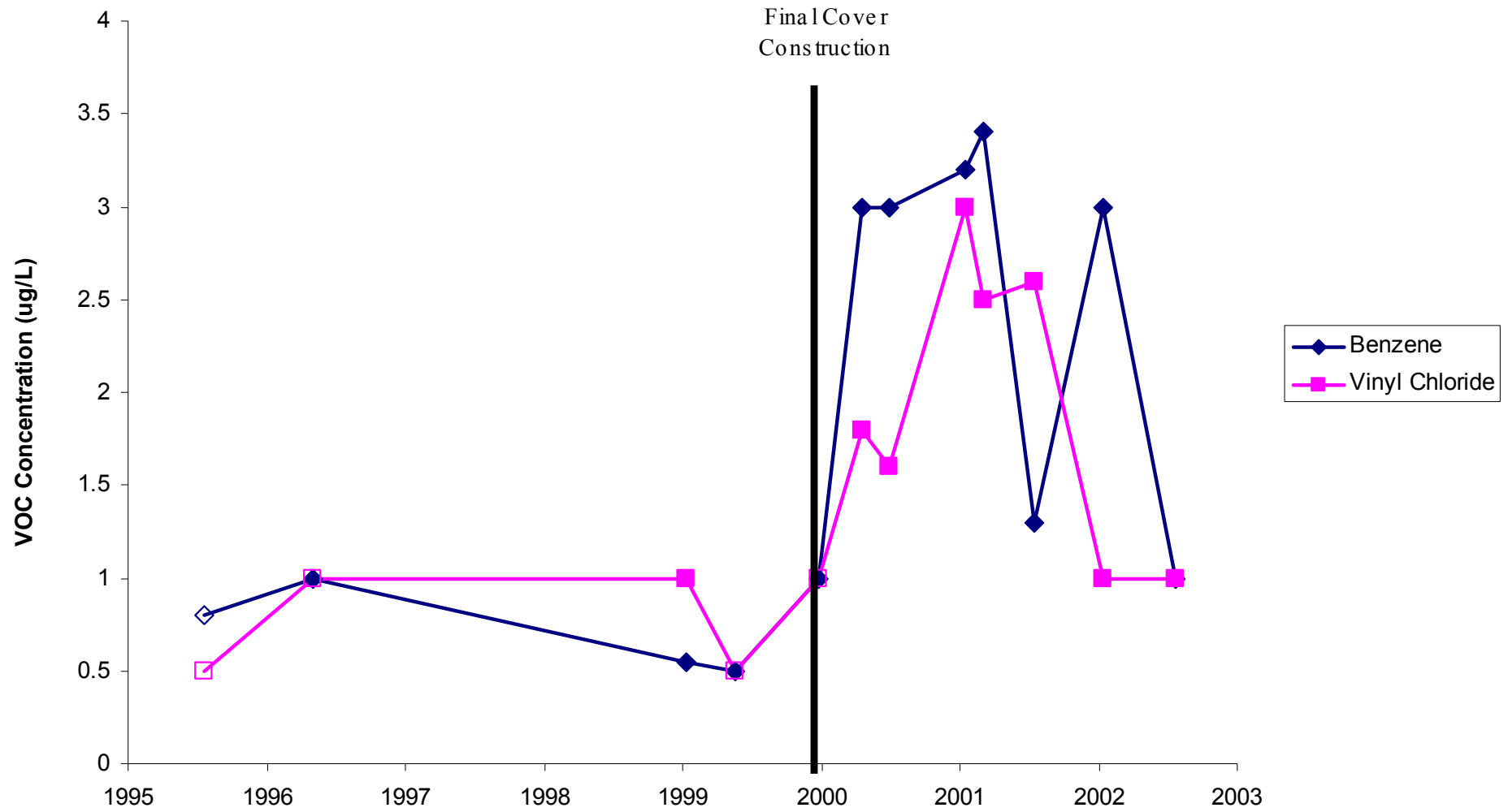


- Reduces gas pressure
- Reduces VOCs in leachate
- Reduces moisture content in landfill

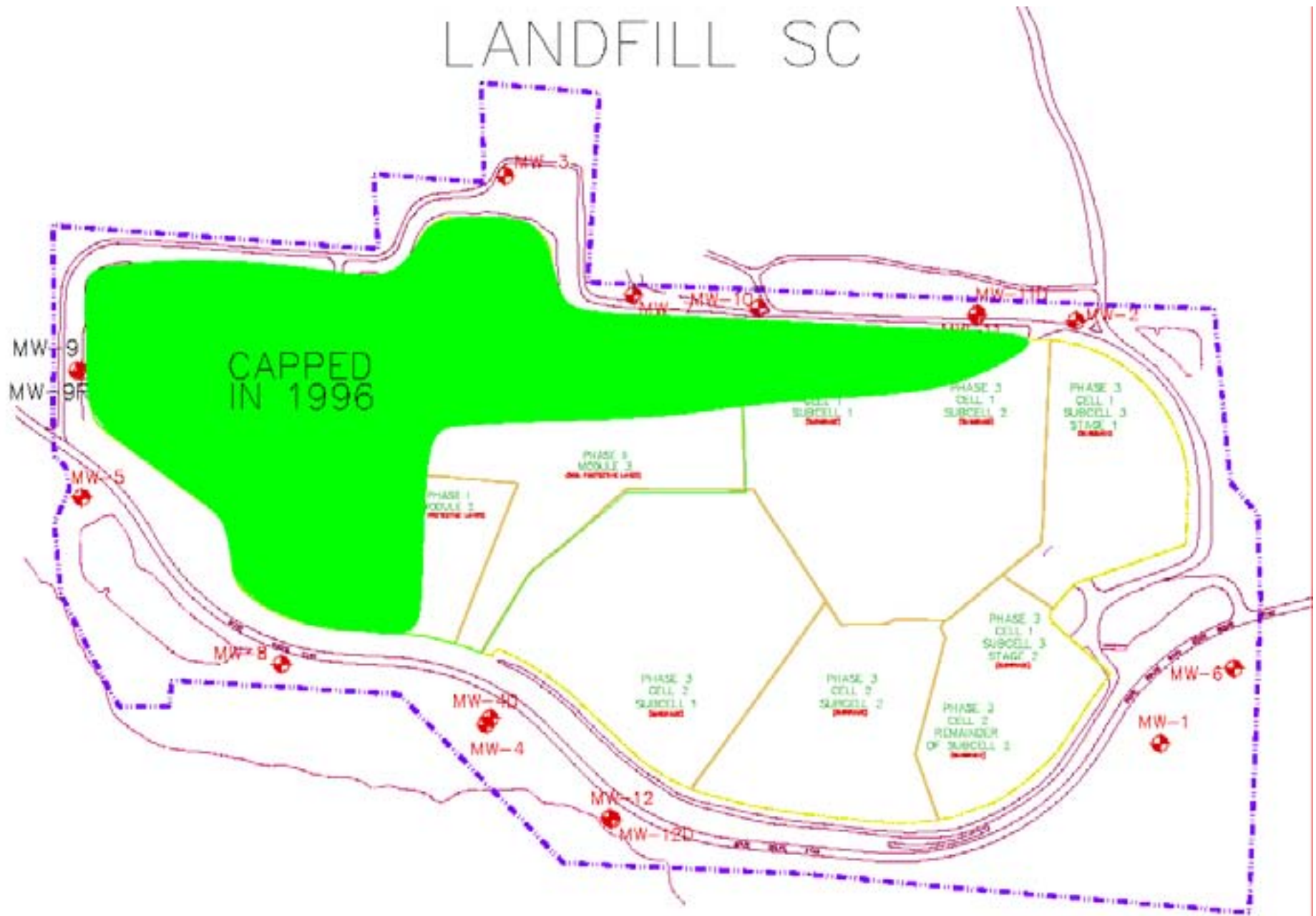
LANDFILL GA



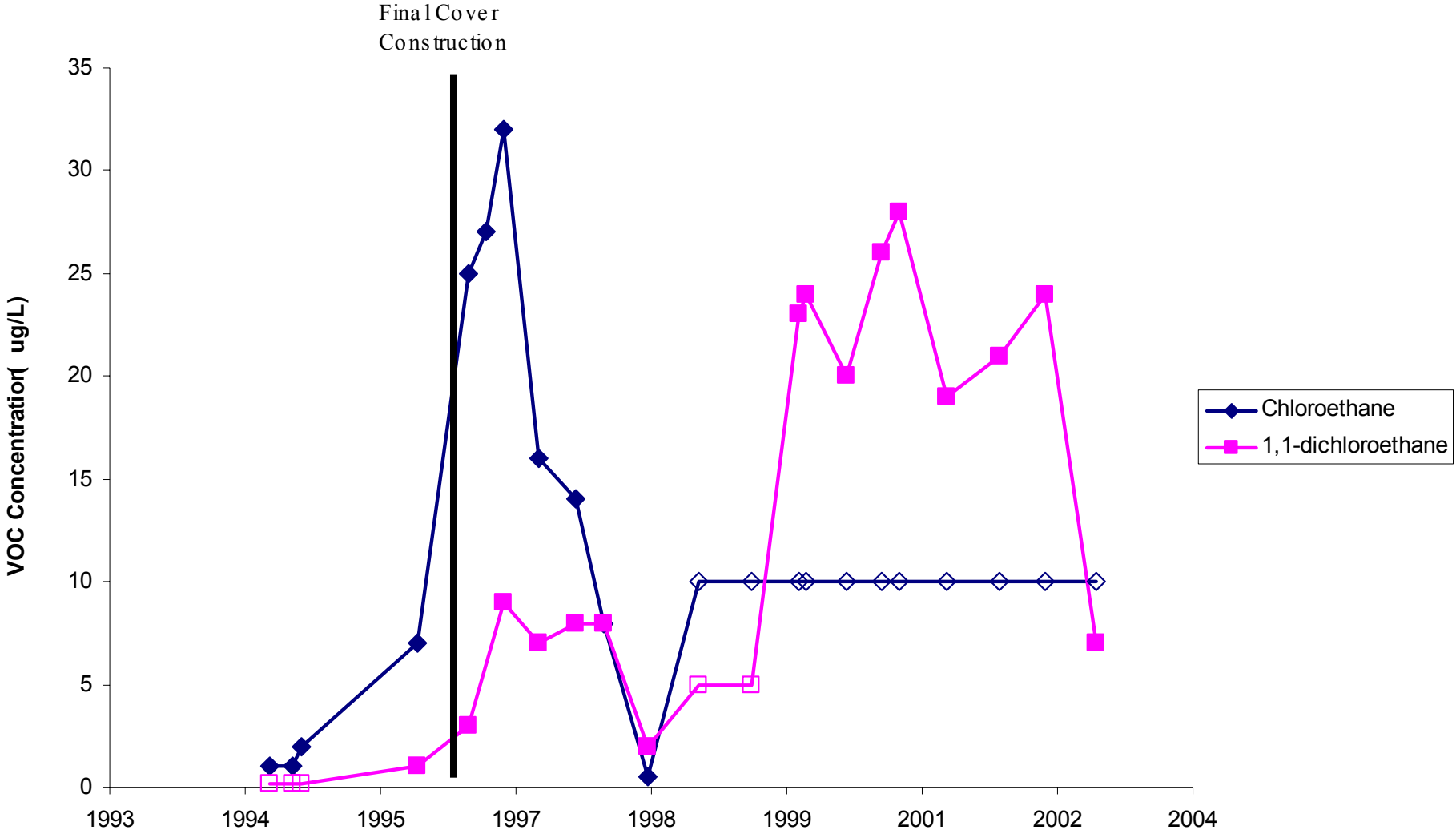
LANDFILL GA
MW-10R



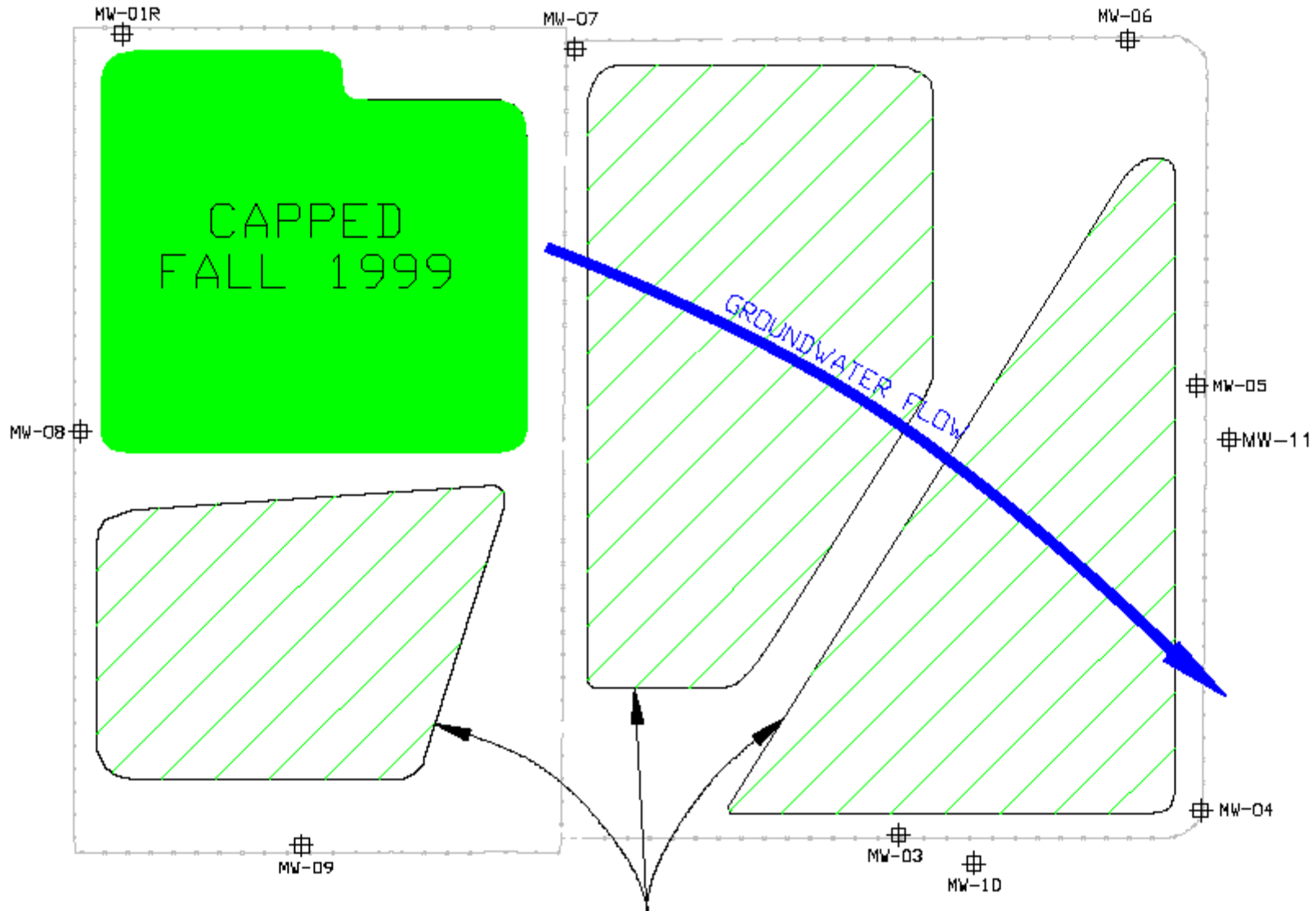
LANDFILL SC



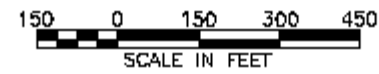
LANDFILL SC
MW-9 AND MW-9R



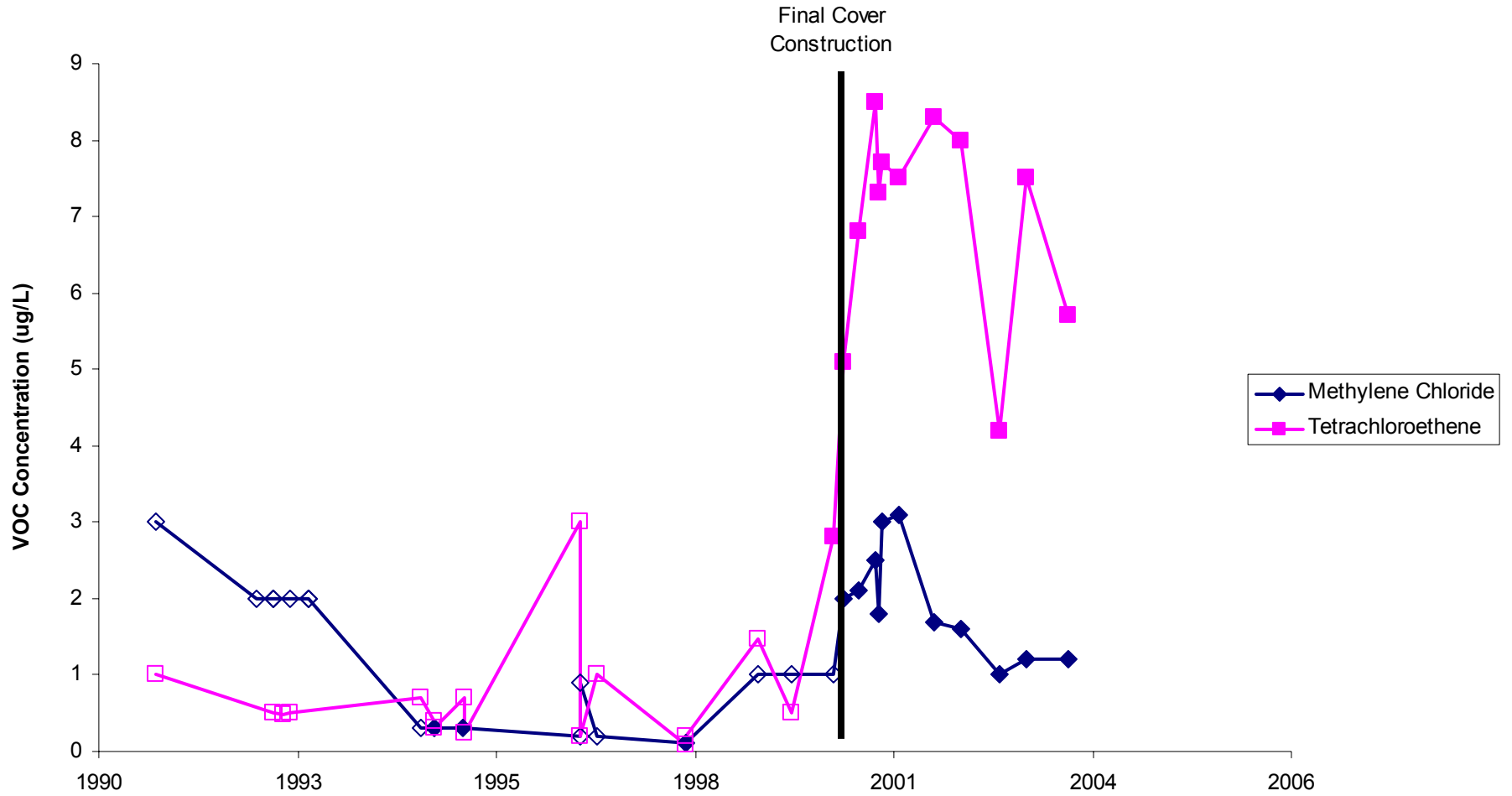
LANDFILL NM



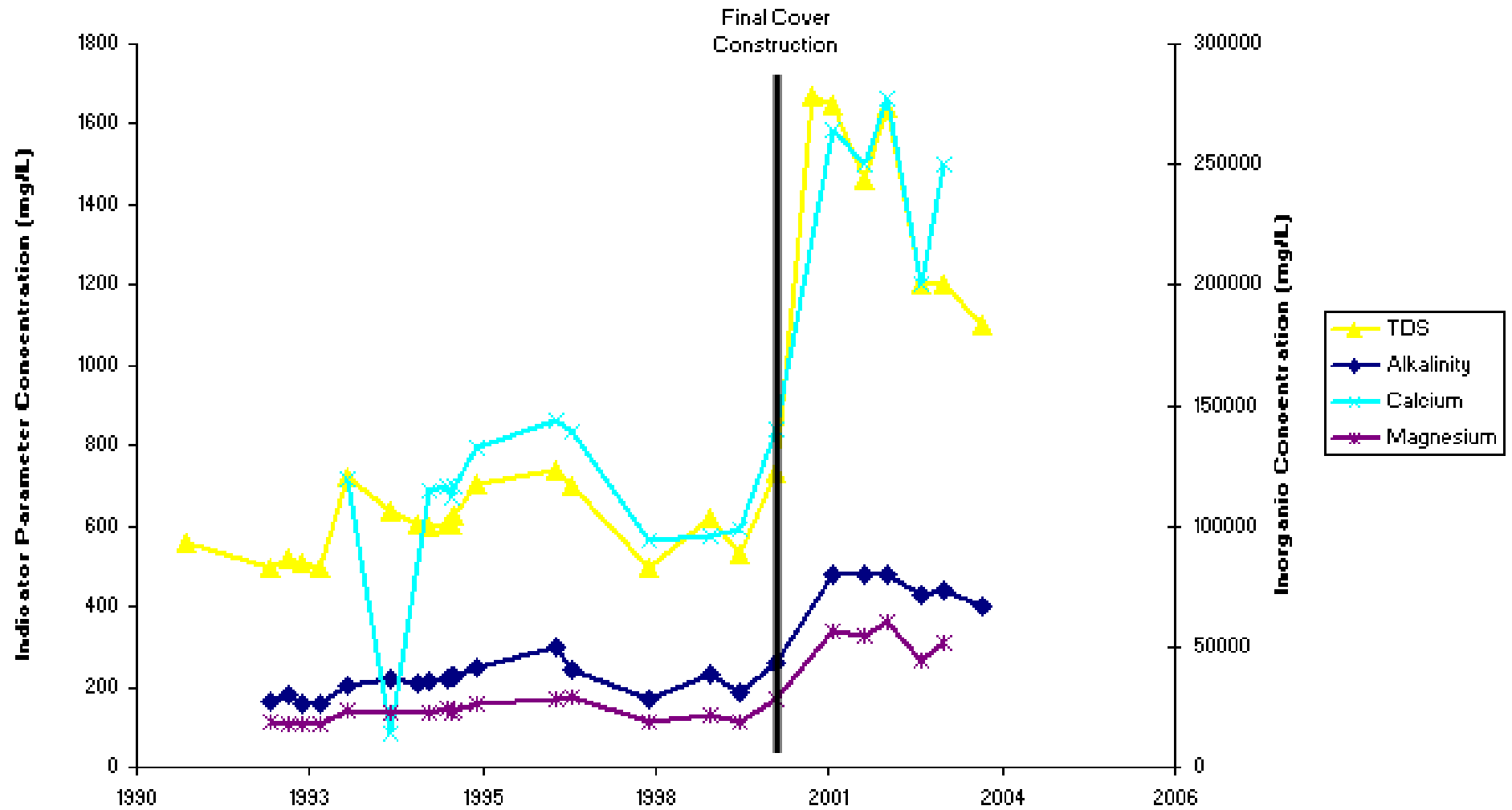
CAPPED
BEFORE 1999



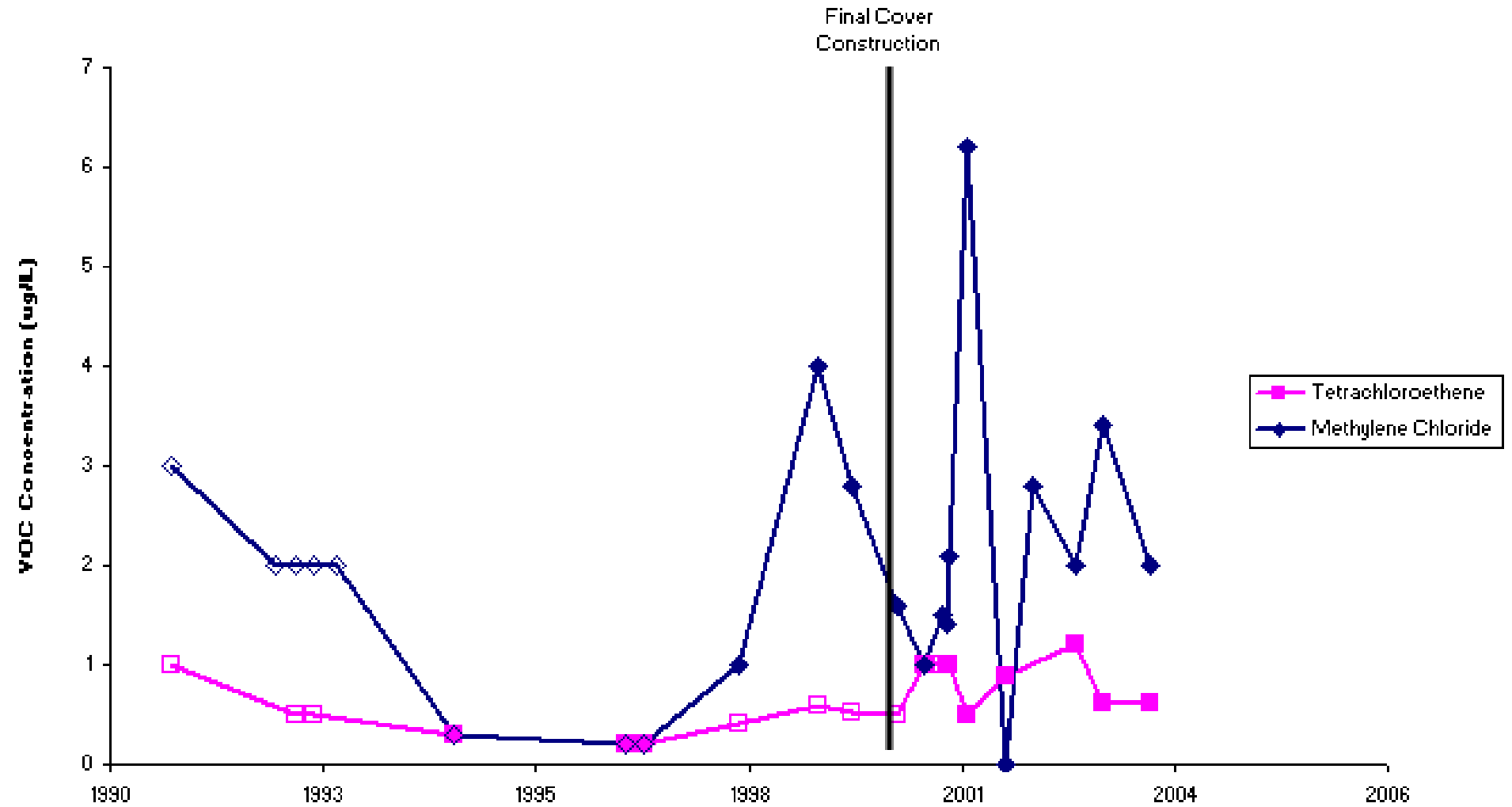
LANDFILL NM
MW-3



LANDFILL NM MW-3

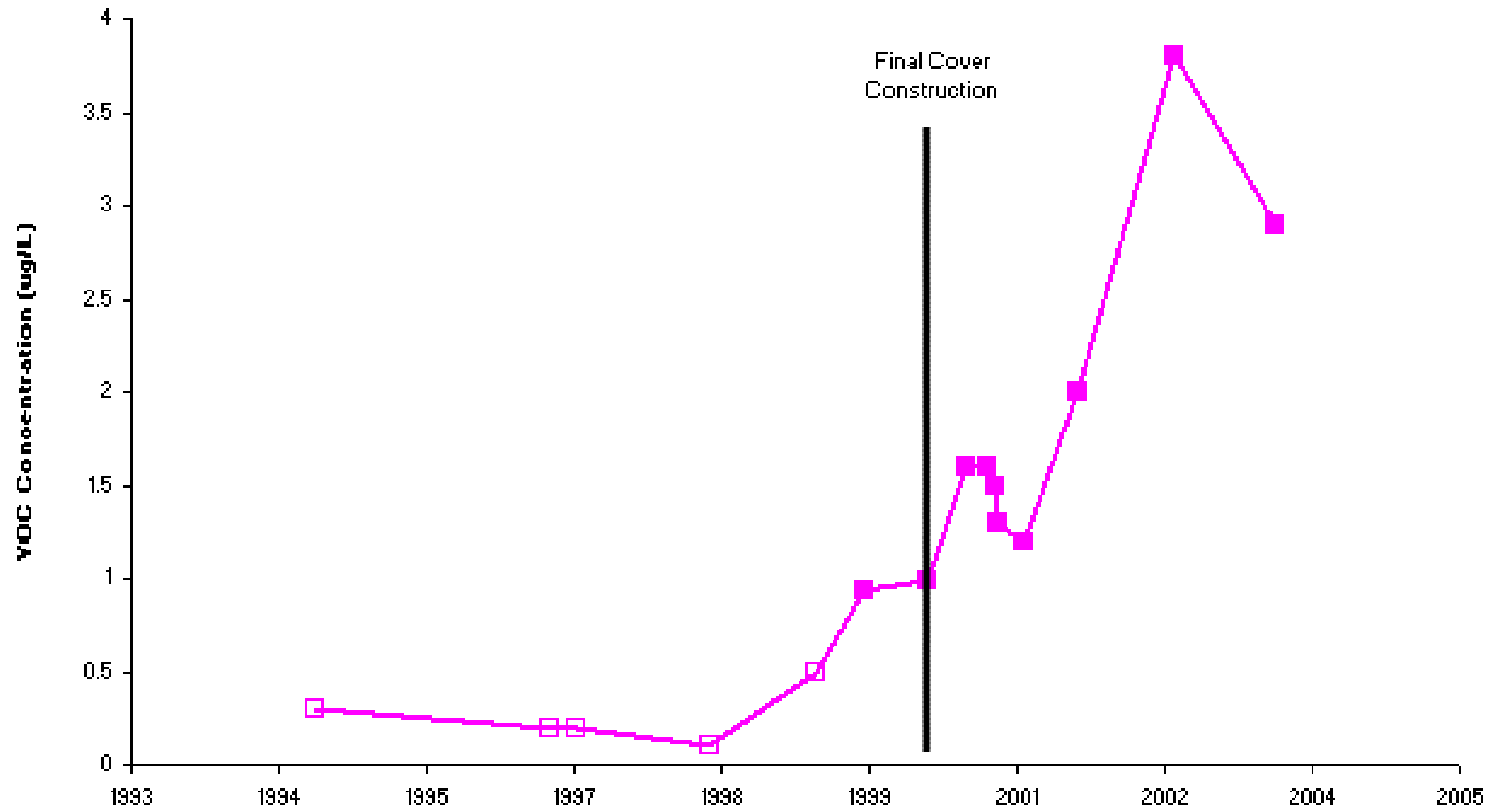


LANDFILL NM
MW-5

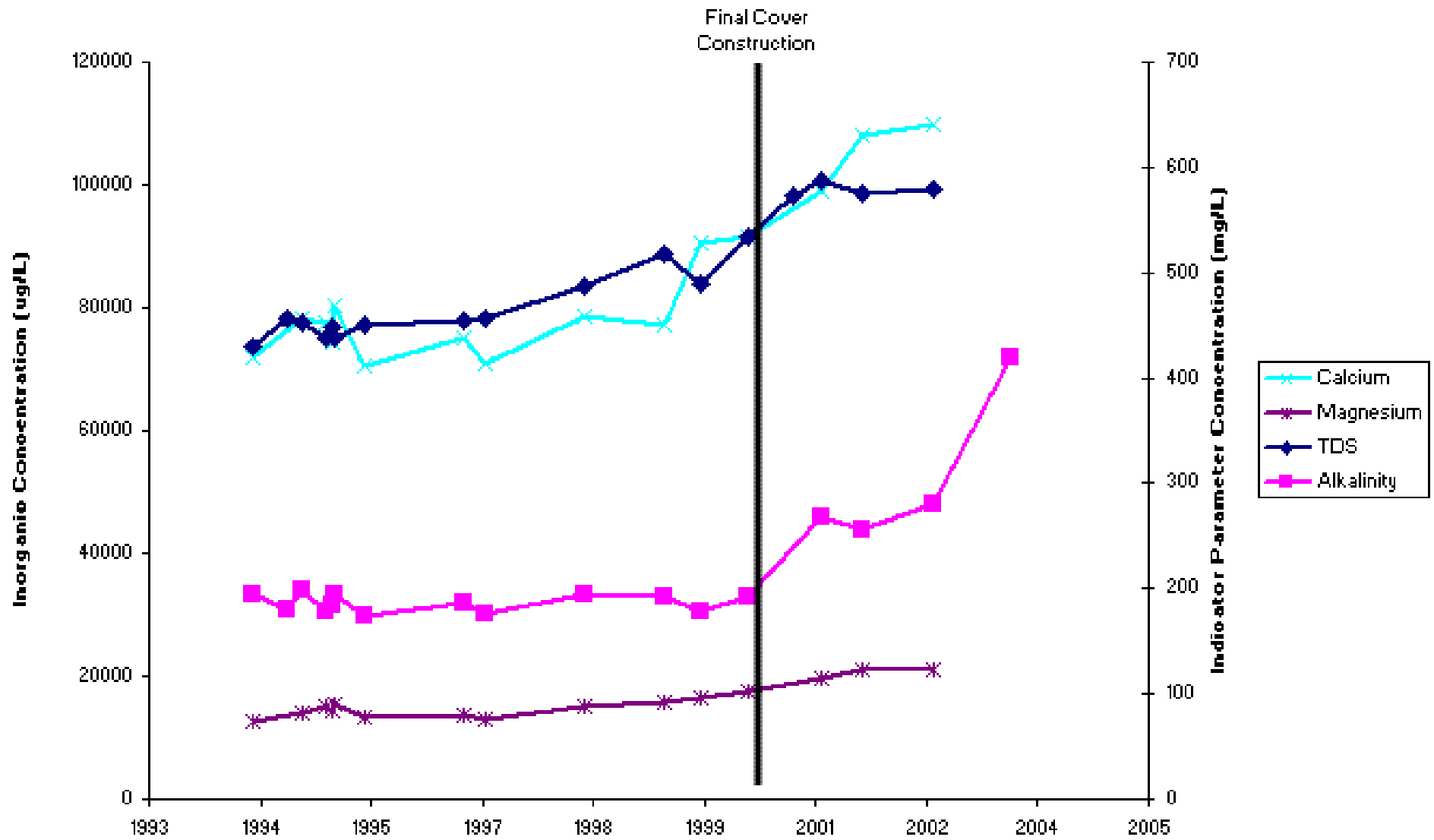


LANDFILL NM
MW-7

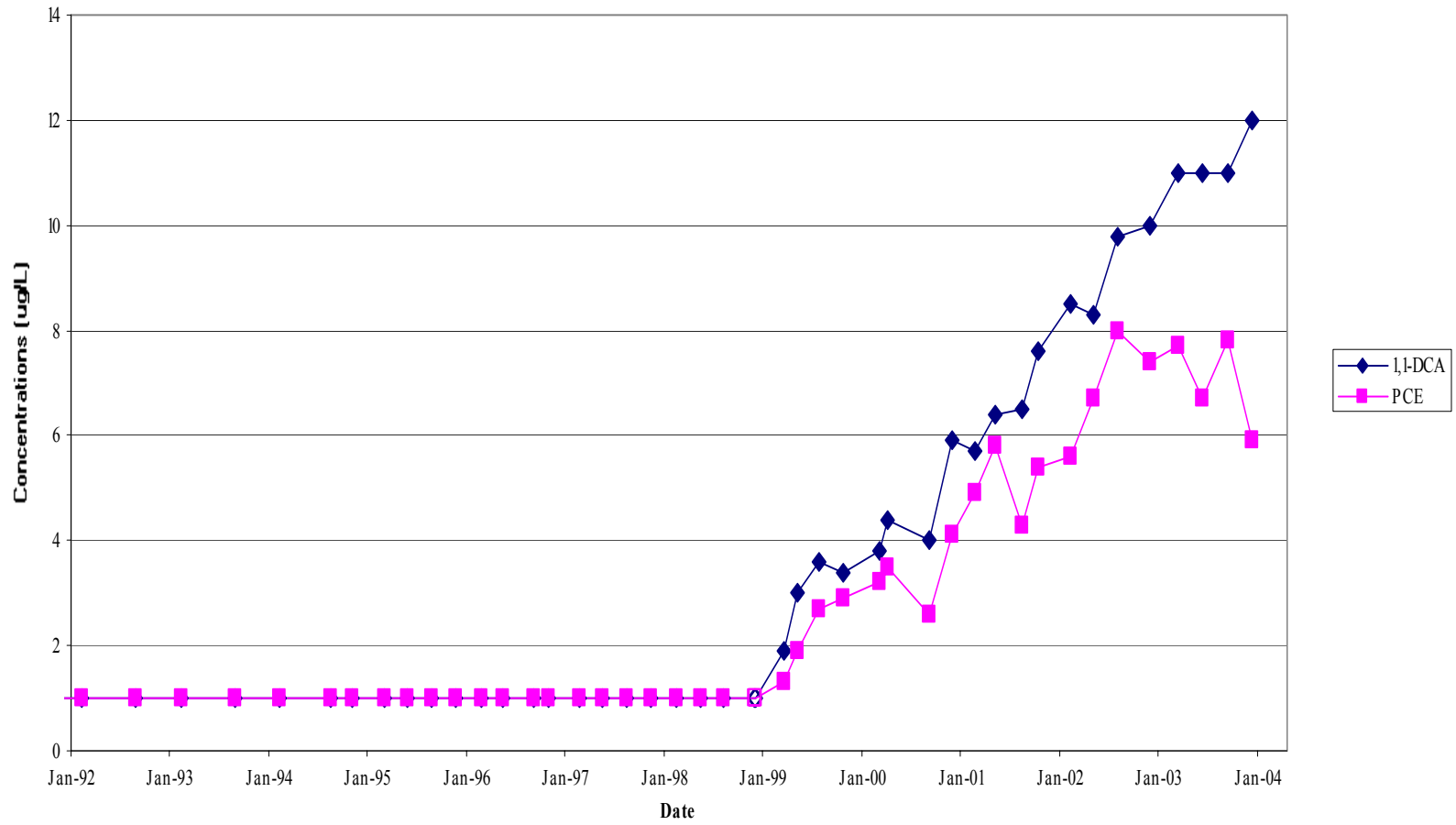
Tetrachloroethene



LANDFILL NM MW-7

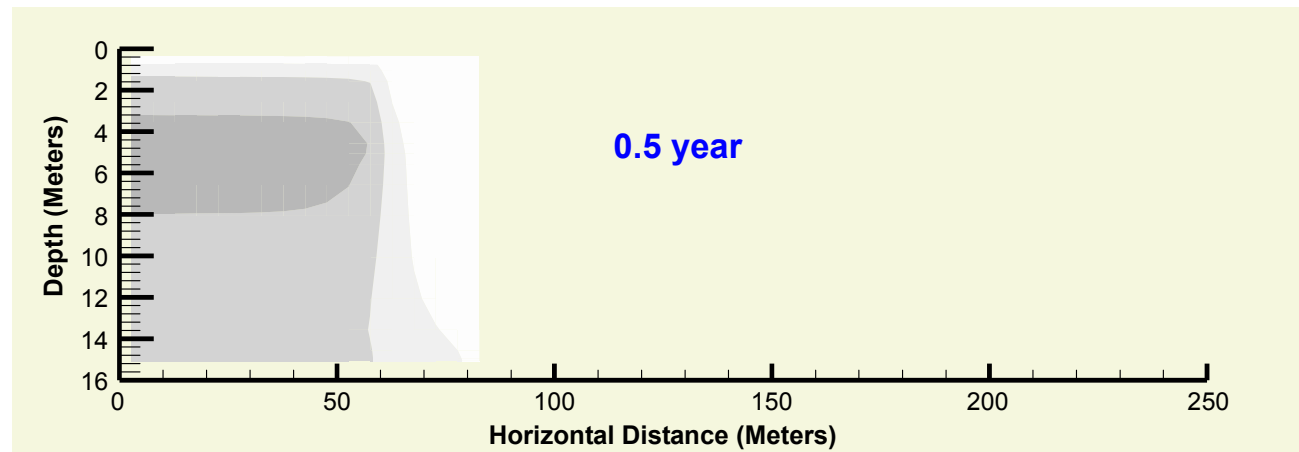


Northwest Landfill

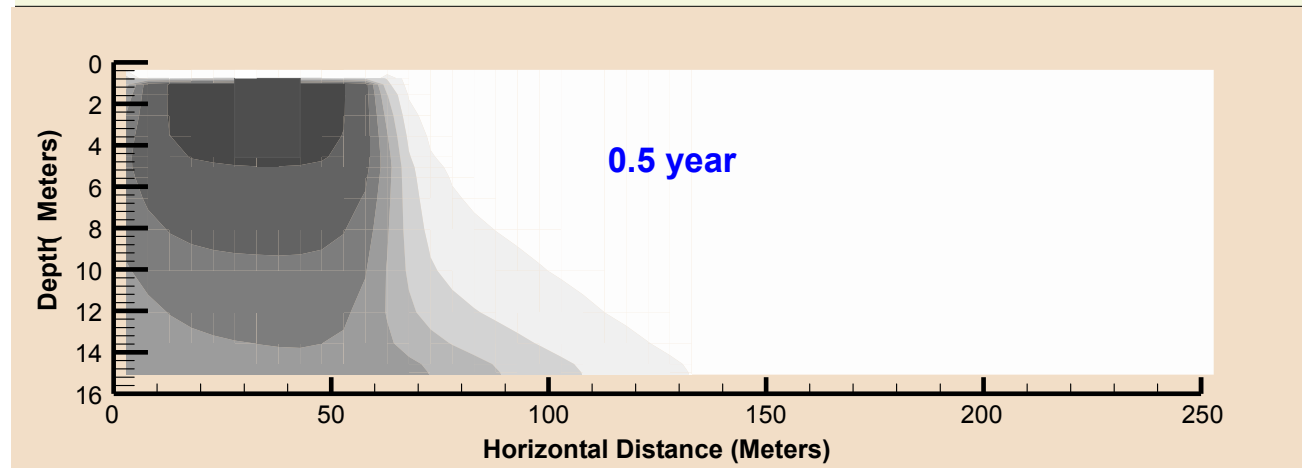


Landfill Gas Movement -Cover Effects-

High K
Cover

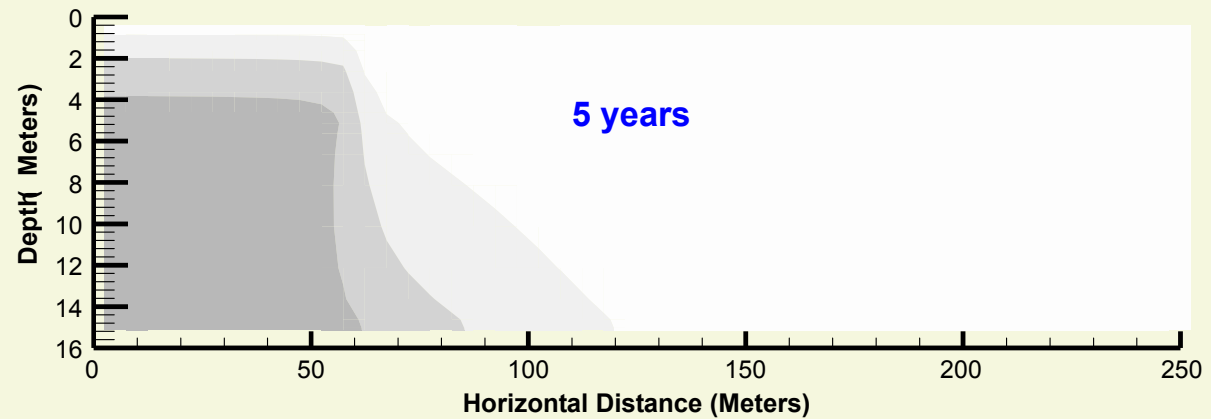


Low K
Cover

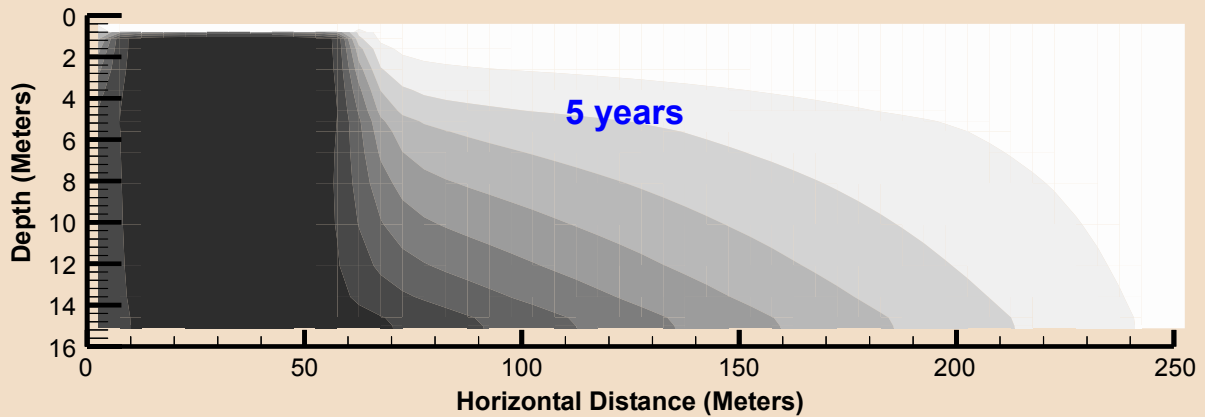


Landfill Gas Movement -Cover Effects-

High K
Cover



Low K
Cover



KEY EVIDENCE OF POTENTIAL LANDFILL GAS VOC IMPACTS TO GROUNDWATER

- Measured Levels of Methane and VOCs in Perimeter Gas Probes and in Groundwater Well Headspace Gas
- No statistical exceedences of inorganic parameters and no trends of any leachate indicators
- Evidence of migration pathway to well
- No isotope evidence of leachate impacts to groundwater

Principal Constituents of MSW Landfill Gas in the Anaerobic Decomposition Stage

Methane: 40 to 70 % (by volume)

Carbon Dioxide: 30 to 50 % (by volume)

Trace Gases: < 5% (by volume)

(Note: Small amounts of nitrogen and oxygen may be present due to atmospheric diffusion.)

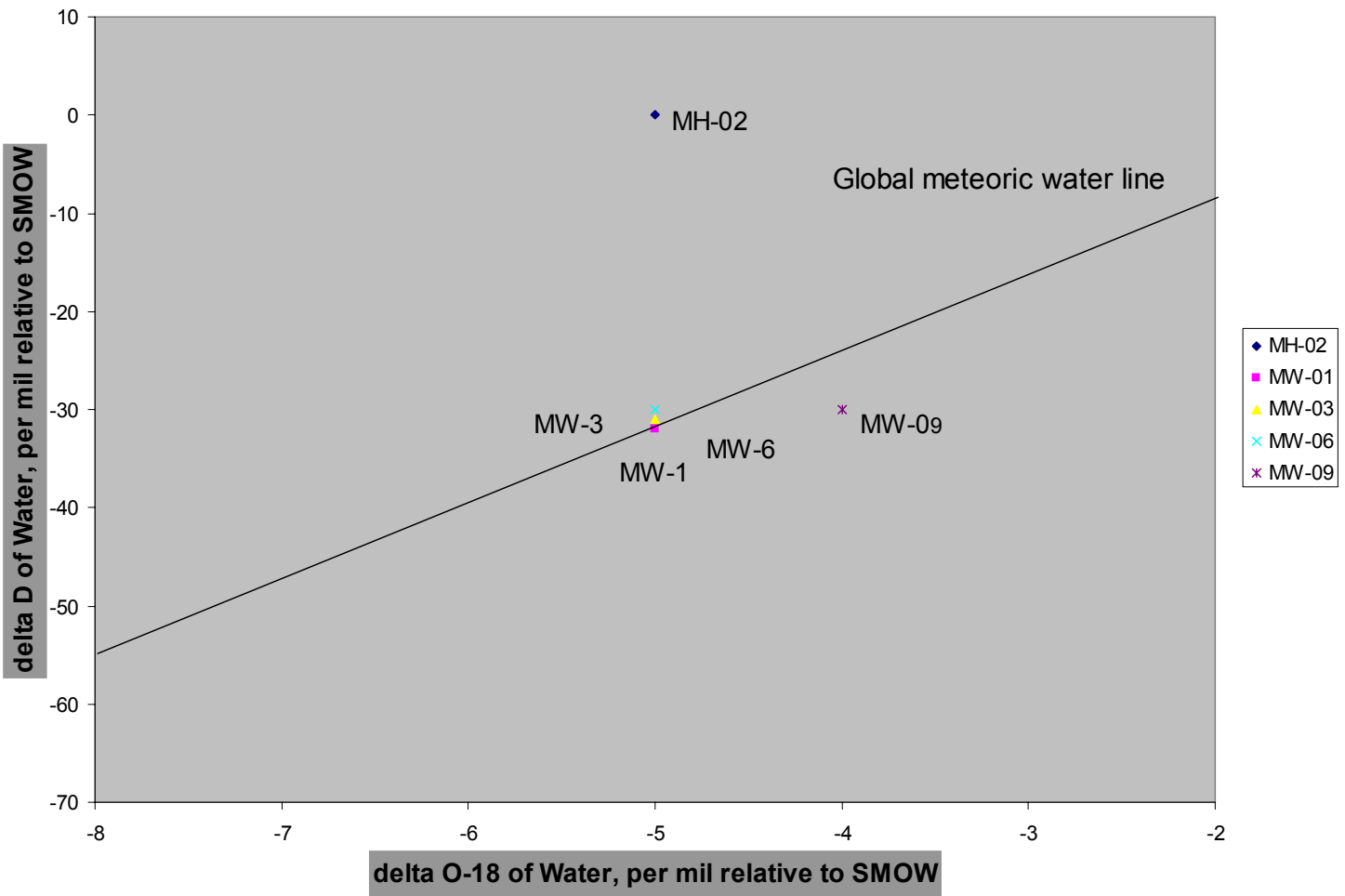
(Source: Brosseau and Heitz, 1993/Kerfoot 1994)

Common Trace Gas VOC's Found in MSW Landfill Gas

Benzene	1,1-Dichloroethane
1,2-Dichloroethane	Dichloromethane
Acetone	Chlorobenzene
Methyl ethyl ketone (MEK)	Tetrachloroethylene
Toluene	Trichloroethylene
Trichloromethane	Ethylbenzene
Vinyl chloride	Xylenes

(Source: Brosseau and Heitz, 1993/ Vogt, 1995)

Delta O-18 vs. delta D



Mechanisms of Gas-Phase Transport

Landfill gas transport can either be by diffusion or advection.

Diffusional transport is affected by:

- Henry's Law (solubility, vapor pressure)
- Porosity
- Bulk density
- Fractional Organic Carbon
- Soil Moisture Content
- Concentration gradients at air/soil/water interfaces

Advective transport is a function of diurnal temperatures, barometric variations, and landfill pressure gradients

SIGNIFICANCE OF GAS IMPACTS TO GROUNDWATER

- Mechanisms of Transport
- Intra-Well (Cross Contamination) vs Groundwater Zone Impacts

⇒ **Addressing Gas Impacts to Groundwater
Requires the Implementation of Alternate
Monitoring and Source Remedy Programs**

**LANDFILL GAS AS A
SOURCE OF VOCs TO
GROUNDWATER CAN BE
CONFIDENTLY
DETERMINED!**

“Bio”- cap

