

# **NORDROCS 2008**

**2<sup>nd</sup> Joint Nordic Meeting on Remediation of Contaminated Sites**  
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## **Environmental Criteria for Re-Use of Contaminated Soil**

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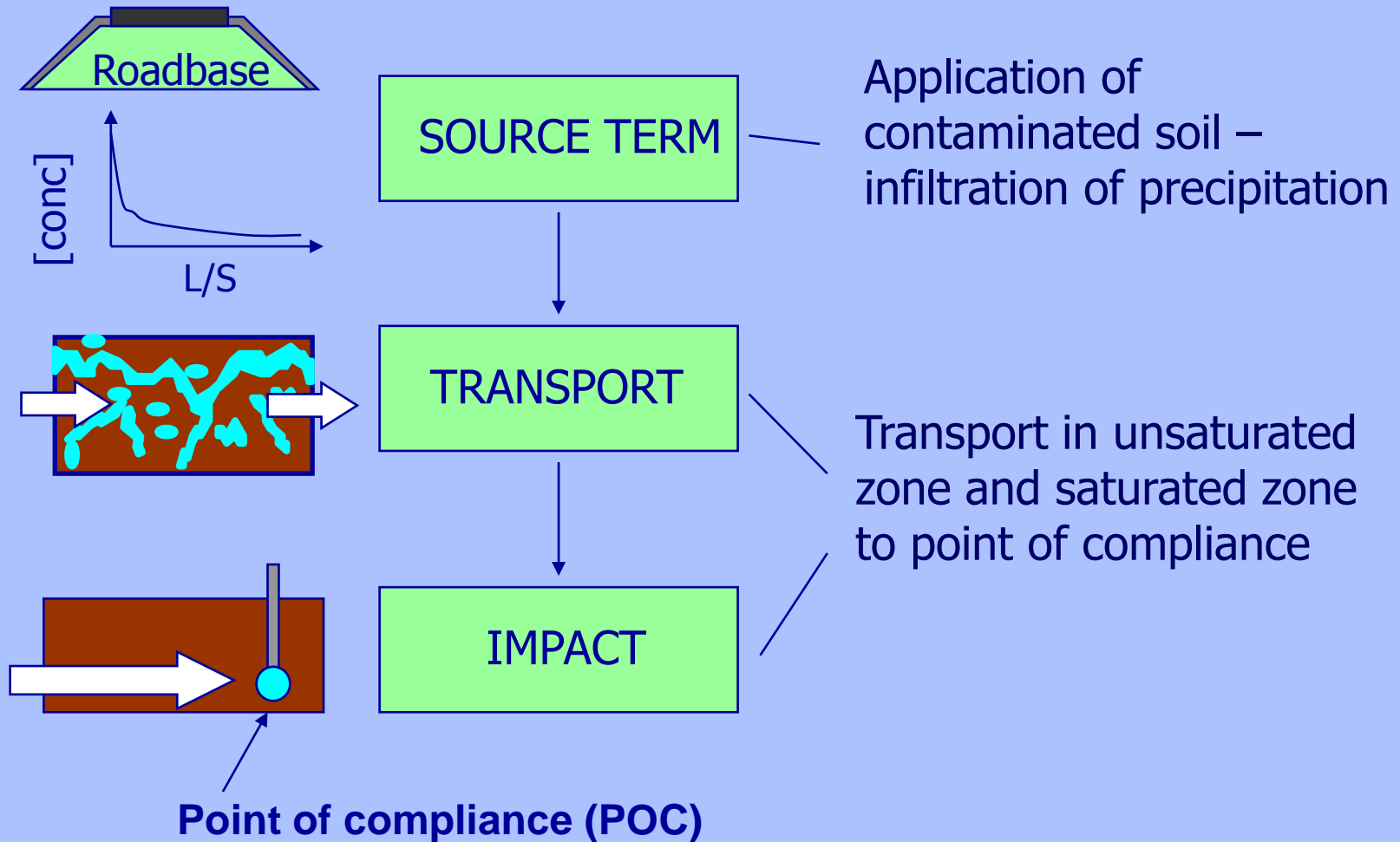
# Overview

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**The message:** When addressing the impact of contaminated soil on groundwater or surface water, the proper tools are correctly chosen leaching tests (not content) in combination with scenario model calculations.

- Leaching tests
- Criteria setting/scenario calculations
- The possible use of an upper limit value of contaminant content in slightly polluted soil as an indication of acceptable leachability
- Conclusions

# Assessment/prediction of environmental impact



# Leaching as a function of L/S: Column test

## Basic characterisation test

CEN/TS 14405: Up-flow percolation test (under specified conditions)

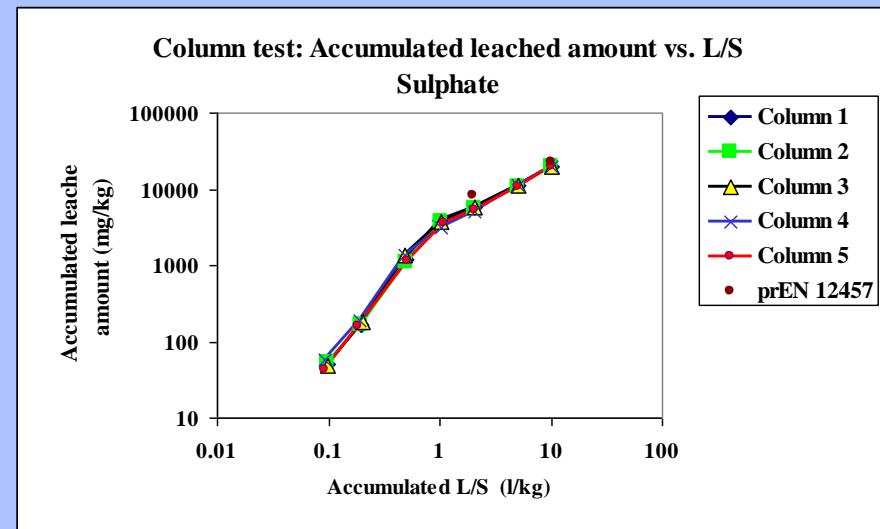
Leaching with 0.001 M  $\text{CaCl}_2$  for soils

L/S = 0 – 10 l/kg

7 eluate fractions

Duration: Approx. 3 weeks

Granular material (< 4 mm)  
Local equilibrium assumed  
Inorganic components



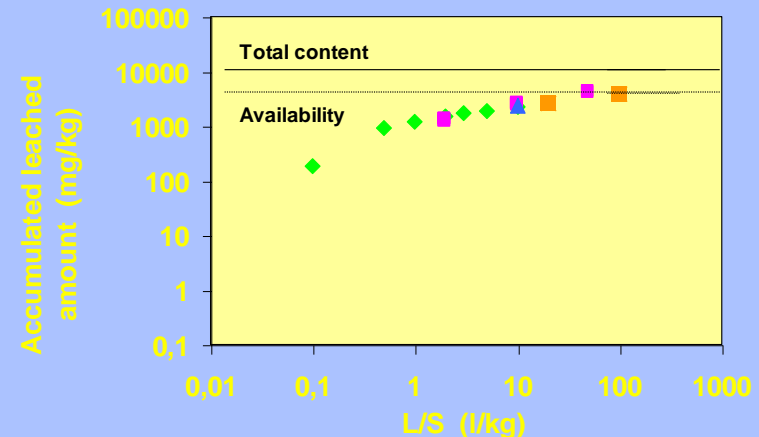
# Leaching as a function of L/S: Batch test

## Compliance test

EN 12457-1

Batch test performed at  
L/S = 2 l/kg, contact time =  
24 hrs, material < 4 mm,  
leachant: 0.001 M CaCl<sub>2</sub> for  
soil

Granular material  
Equilibrium-like conditions



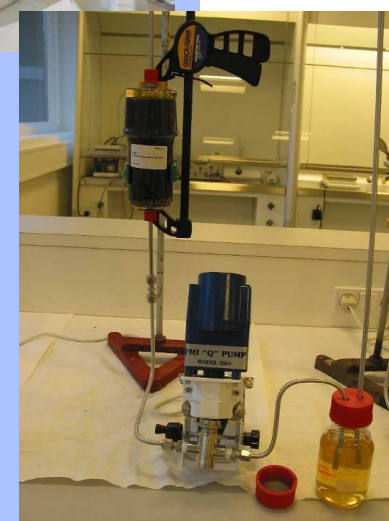
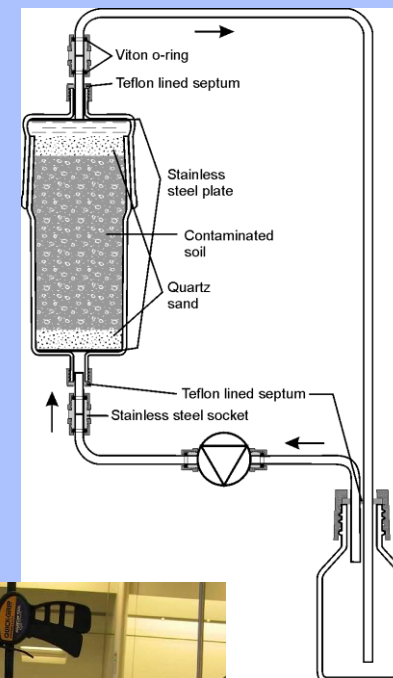
# Leaching test for non-volatile organic substances: Equilibrium recirculation column test

**Column test with recirculation developed by DHI og DTU for the Danish EPA.**

**Determinaton of near-porewater concentration under equilibrium-like conditions for non-volatile organic substances (e.g. hydrocarbons, PAHs and PCBs) in soil and waste (L/S = ca. 1 l/kg). Duration = Approx. 7 days.**

**Tested in a Nordic project with a good result. Applied to 40 – 50 soil samples by DHI.**

**Expected to be implemented as a Danish (and Swedish) standard in 2008/2009**



# Leaching as a function of L/S

**L/S can be converted to a time scale for a given scenario:**

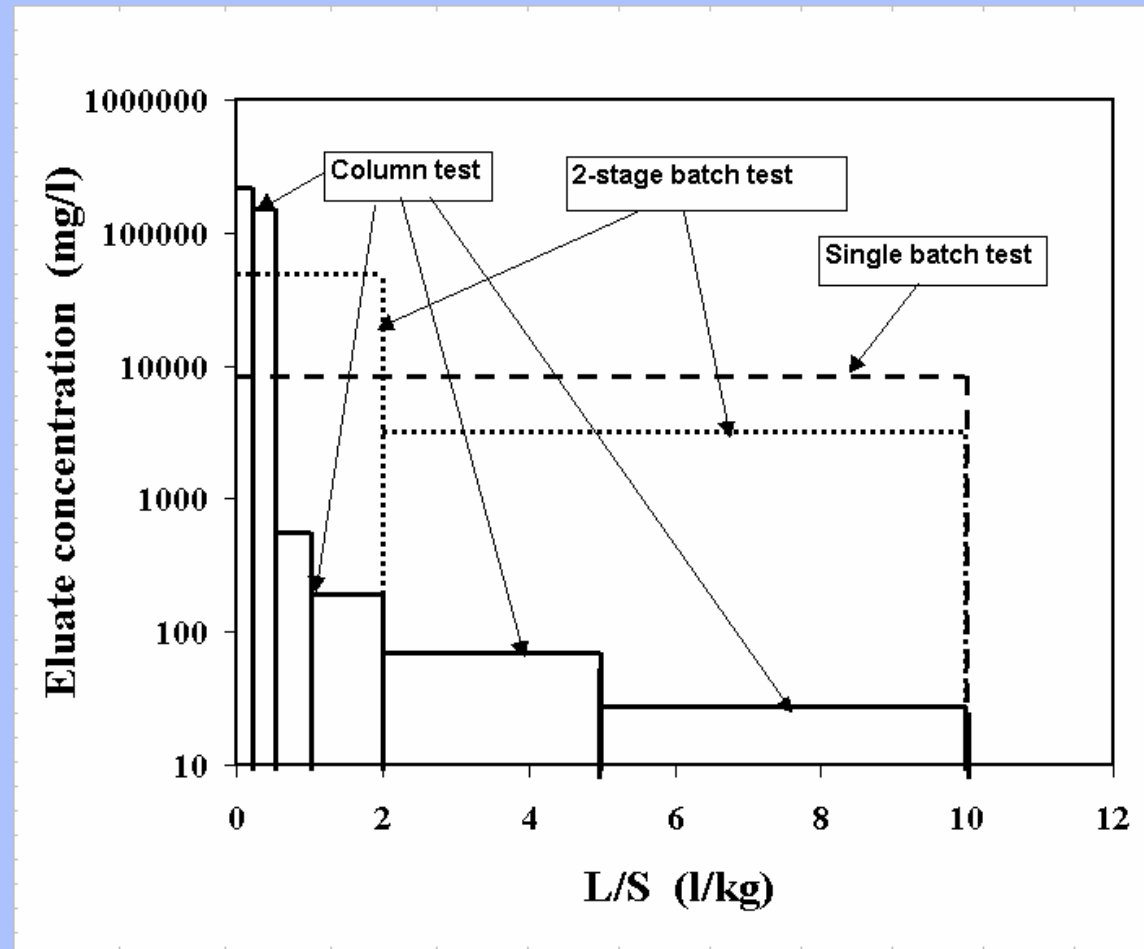
$$t = t_0 + (L/S) \times d \times H/I$$

$t_0$ : time when the first leachate occurs

$d$ : dry bulk density of the soil

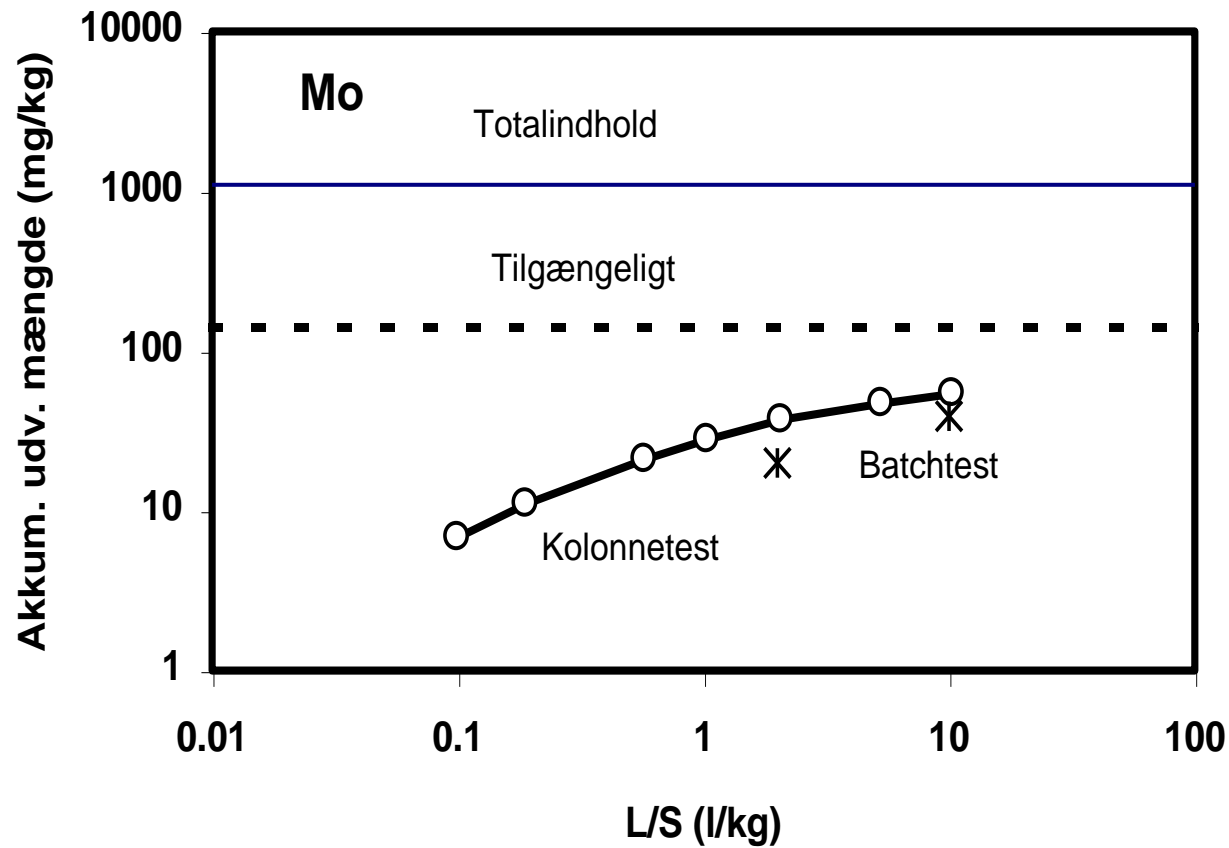
$H$ : height of the application

$I$ : Net infiltration rate

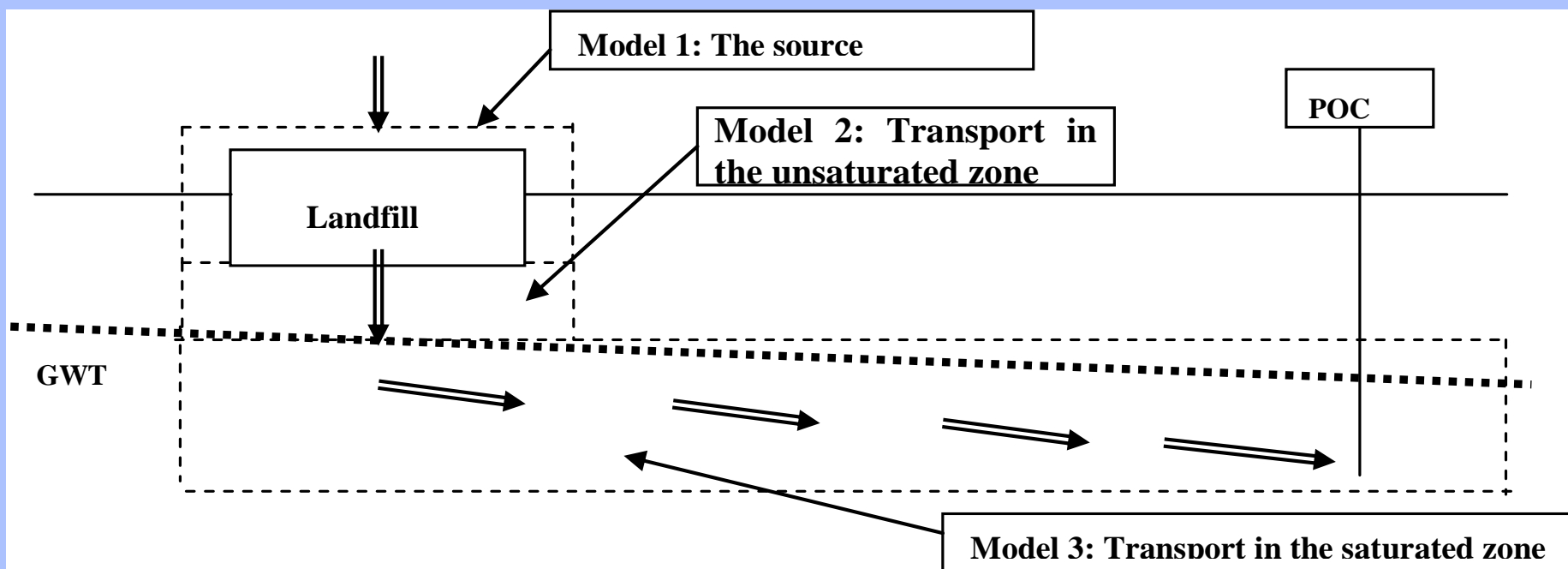


**L/S = Liquid to solid ratio (l/kg)**

# Udvaskning som funktion af L/S



## The EU scenario-based WAC model calculations



$$C = C_0 \times e^{-(L/S)k}$$

$$E = (C_0/k)(1 - e^{-(L/S)k})$$

**WAC = Waste Acceptance Criteria**

**POC = Point Of Compliance**

$$\text{Attenuation factor } f = C_{\text{Max POC}} / C_{0 \text{ Max}}$$

**$C_0$  = Concentration in leachate at the bottom of the landfill**

## **Scenarios/criteria used in the DEPA study**

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**Use with certain restrictions (attenuation included):**

- **Scenario 1: H = 1 m, L = B = 100 m, distance to POC = 30 m**
- **Scenario 2: H = 5 m, L = B = 100 m, distance to POC = 30 m**

**GWQ criteria at POC:**

**Cu = 0.1 mg/l    Pb = 0.005 mg/l**

**Free use (attenuation not included):**

**Initial leachate (porewater) must comply with GWQ criteria**

**GWQ criteria:**

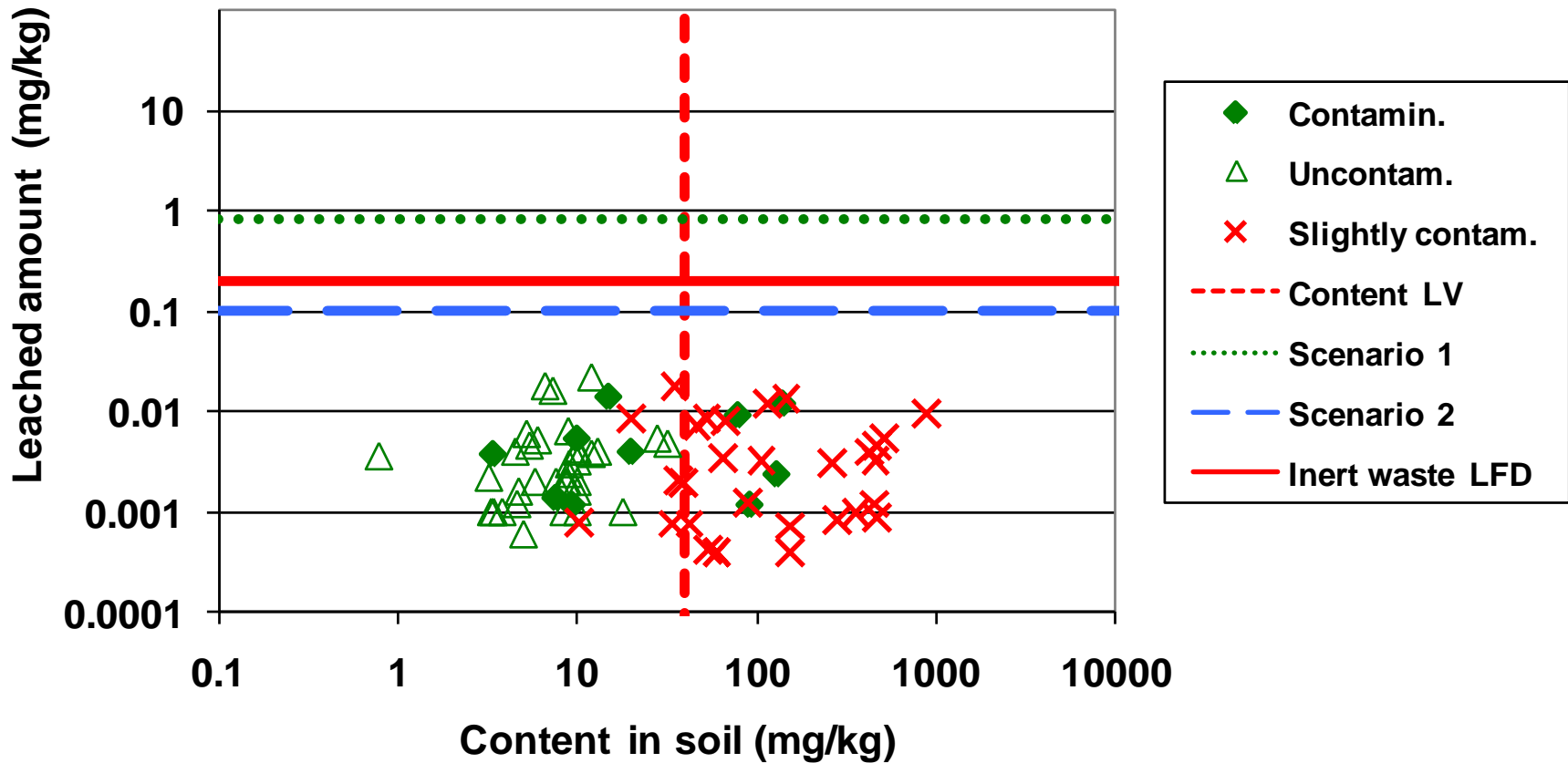
**Pb = 0.001 mg/l                      PAHs = 0.0002 mg/l (carcinogenic)**

**(+ 10 x GWQ criteria)**

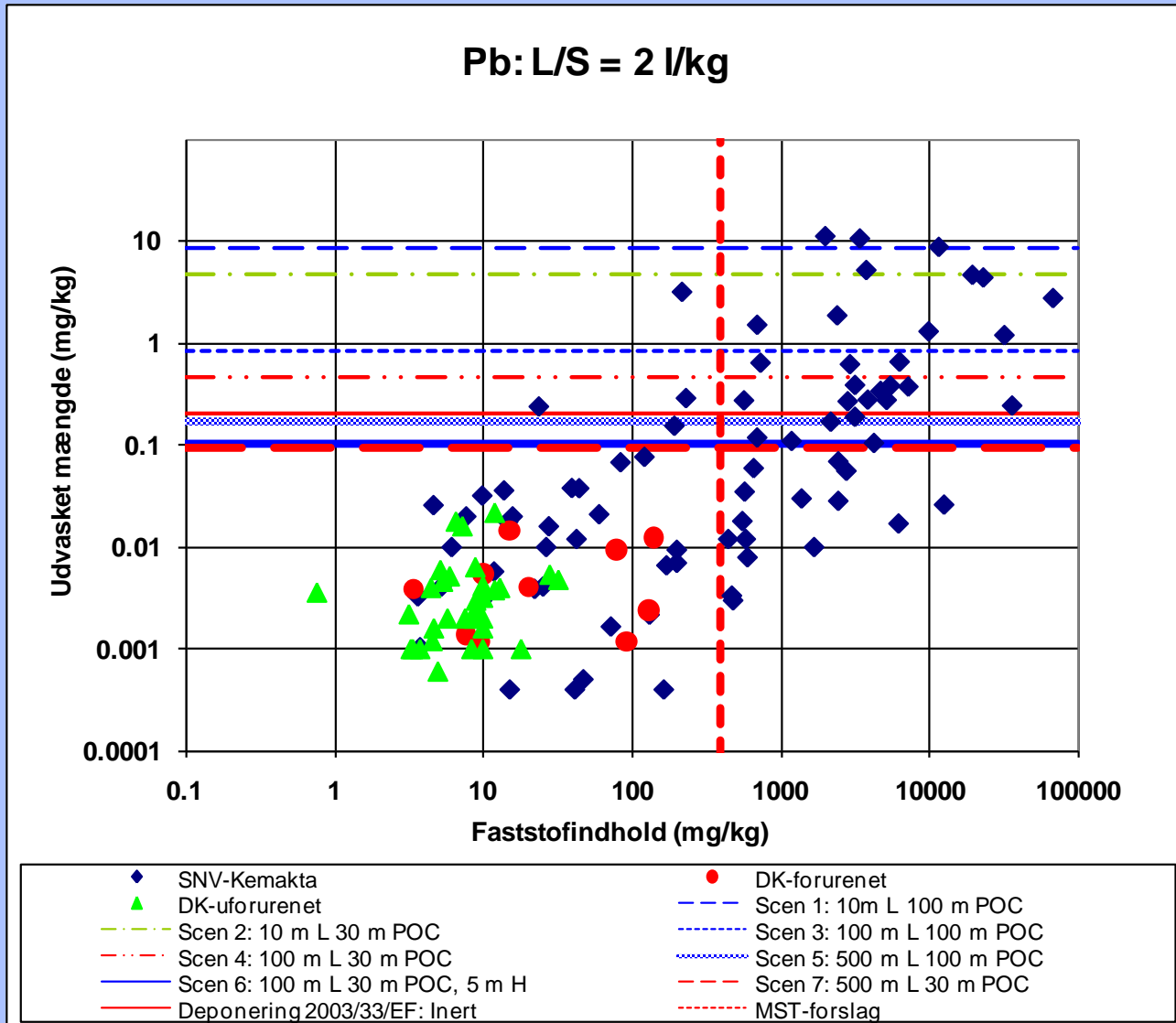


## Scenarios with attenuation (retardation, dilution)

**Pb: Leaching from soil at L/S = 2 l/kg vs. content**

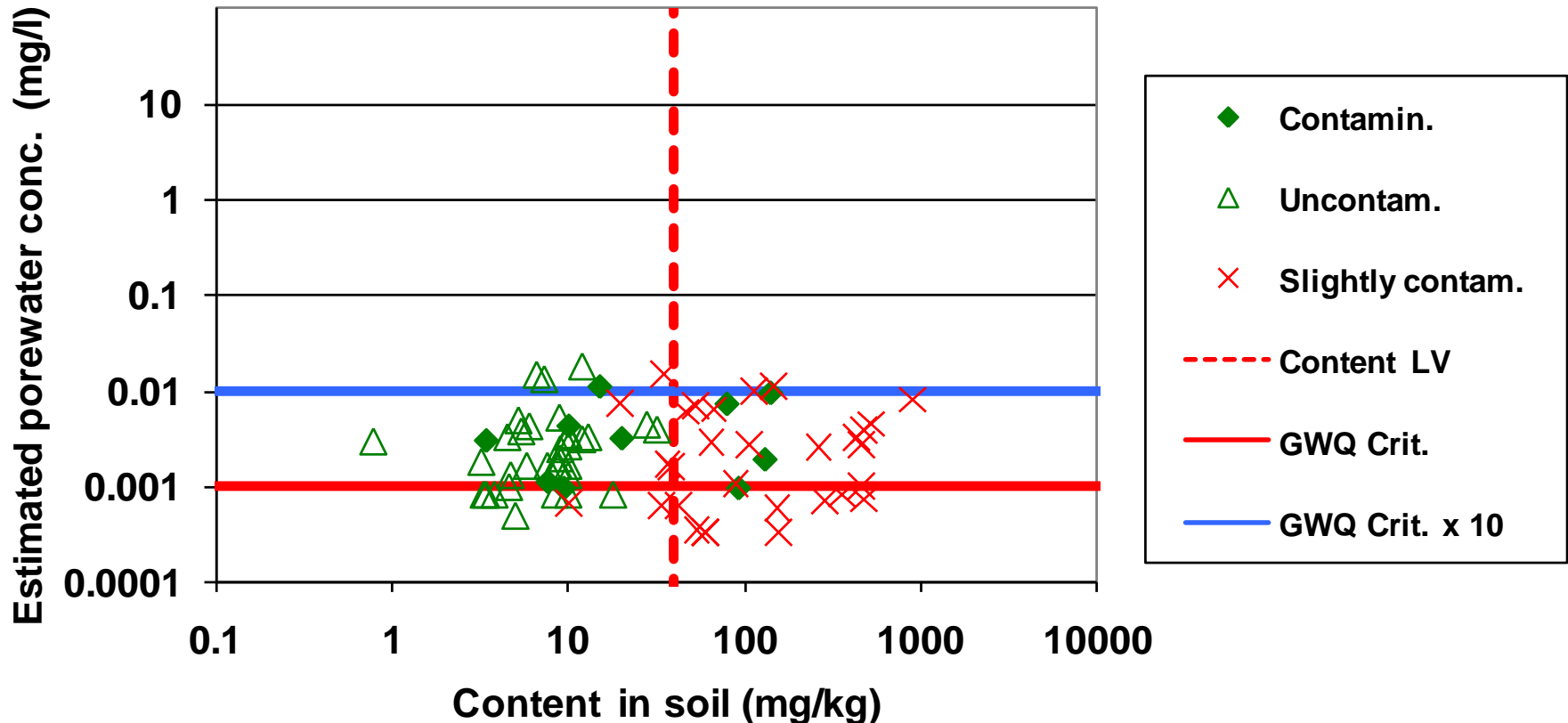


## Scenarios with attenuation (retardation, dilution)



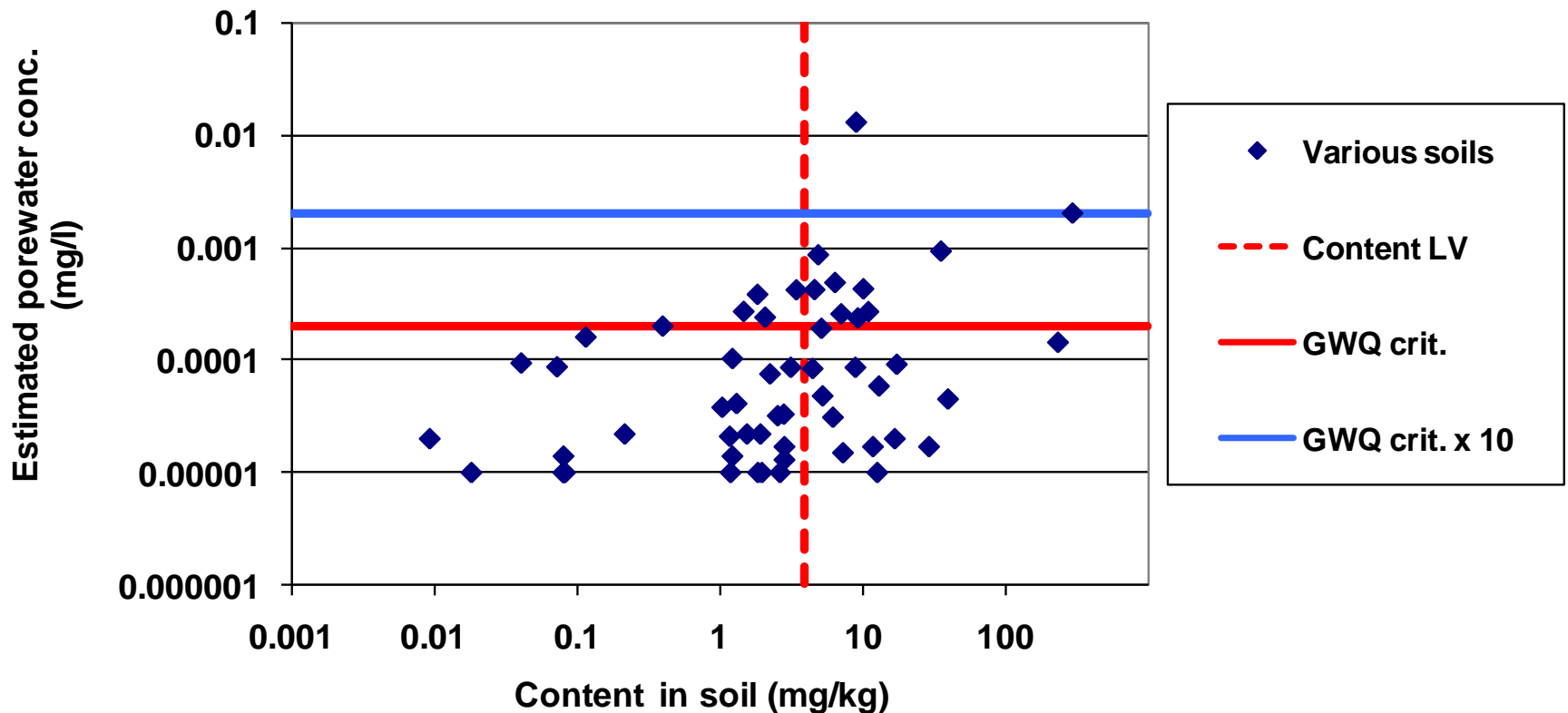
## Scenarios without attenuation

**Pb: Leaching from soil at L/S = 2 l/kg vs. content**  
Data converted to porewater concentrations



## Scenarios without attenuation

**Sum of PAHs: Leaching from soil at L/S = 0.8- 1.5 l/kg vs. content**  
Data converted to porewater concentrations



# Conclusions

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- In general, there is no direct relationship between the content of a contaminant in soil and the leachability of that contaminant.
- Assessments of the impact of utilisation (or landfilling) of contaminated soil on groundwater or surface water should therefore be based on the leaching properties of the soil, not on the content of the contaminants.
- The impact assessment should be based on appropriately chosen leaching test(s) in combination with scenario/model calculations.
- For some contaminants it seems possible to set a maximum value for the content in soil that will ensure that the environmental impact caused by leaching from soils with contents below this value will be acceptable (e.g. in relation to re-use).
- For other contaminants it does not seem possible to set such an upper limit, or the limit will have to be very low and therefore not very useful in practice.