Modeling Issues and Problems

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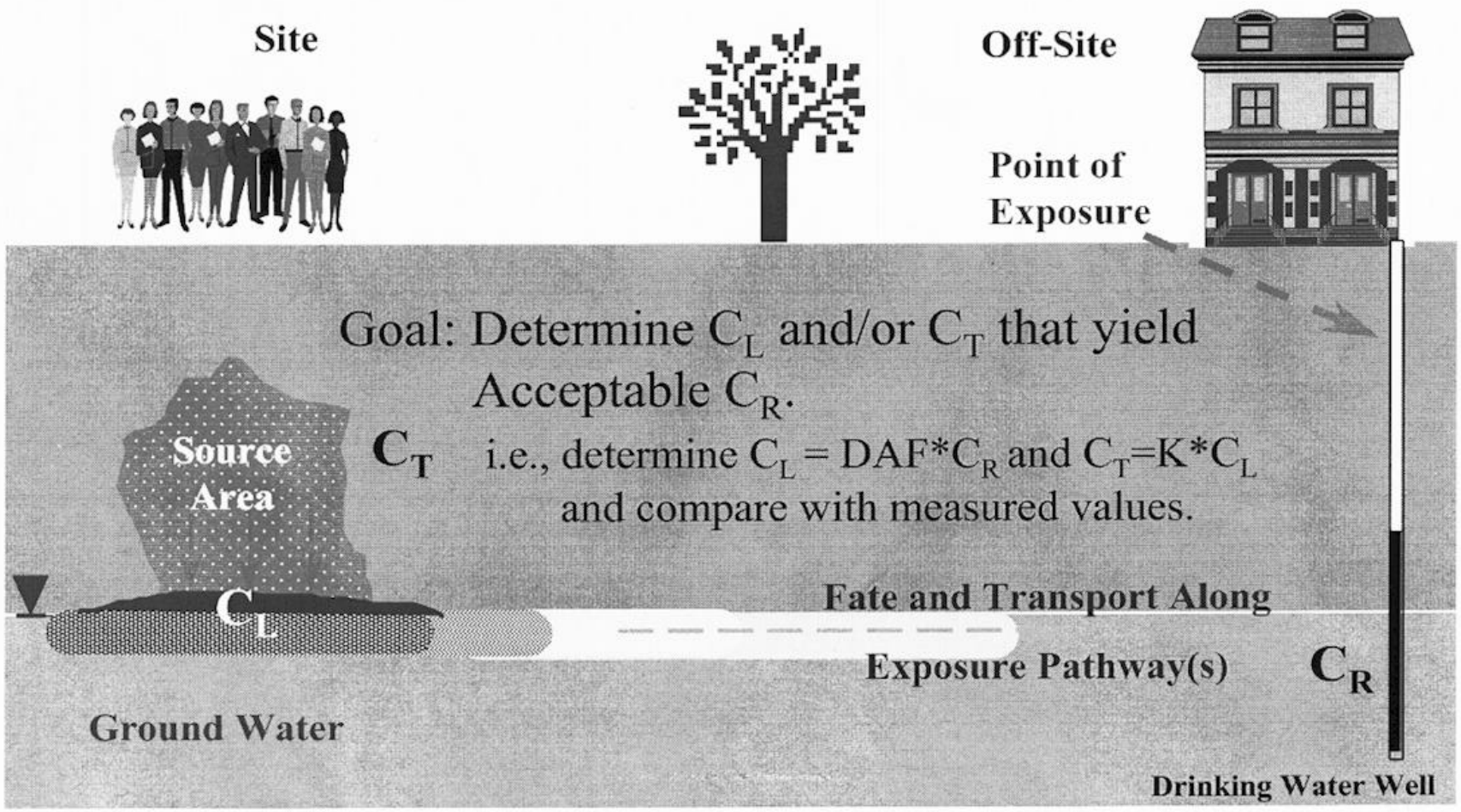
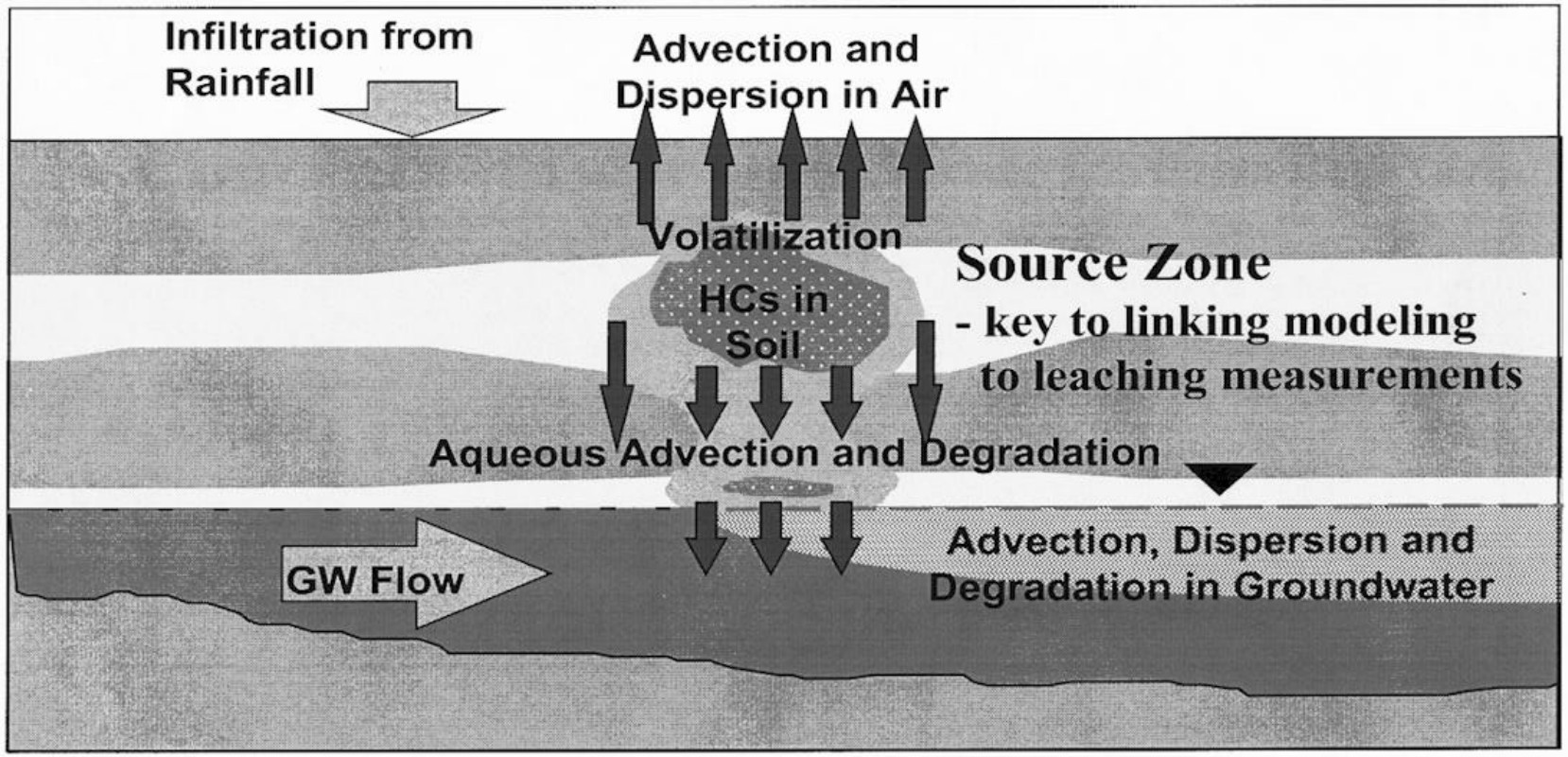
Leaching Modeling Issues

- What are our objectives?
- How do we model the system to reflect these objectives? (Source Zone is the key).
- What are the appropriate model parameters that we should measure?
- How should we best measure them?

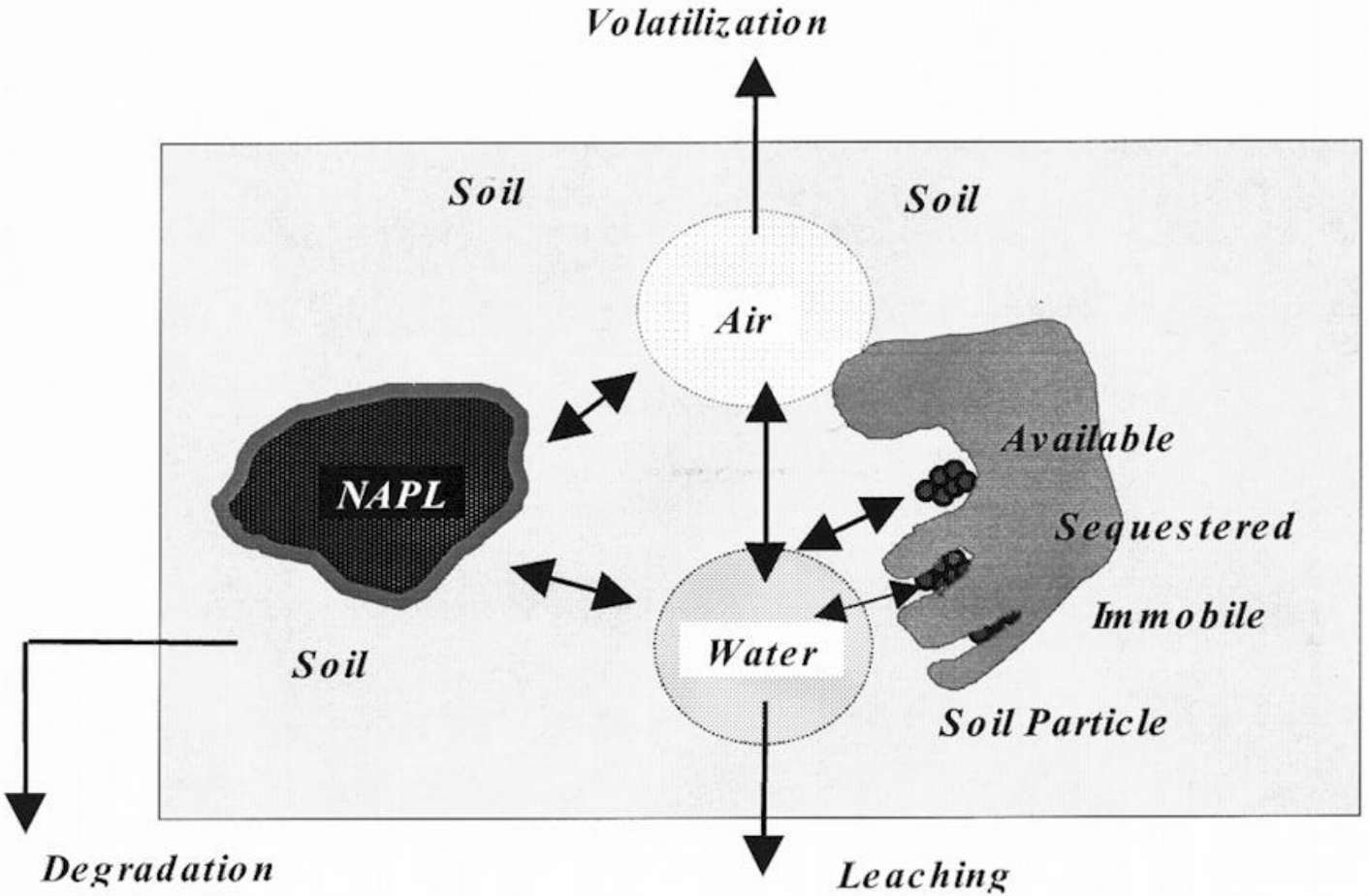
Modeling Leaching to a Groundwater Receptor



A Conceptual Leaching Model Showing the Significant Transport Processes



Conceptual Model Showing Significant Fate & Transport Processes in Source Zone

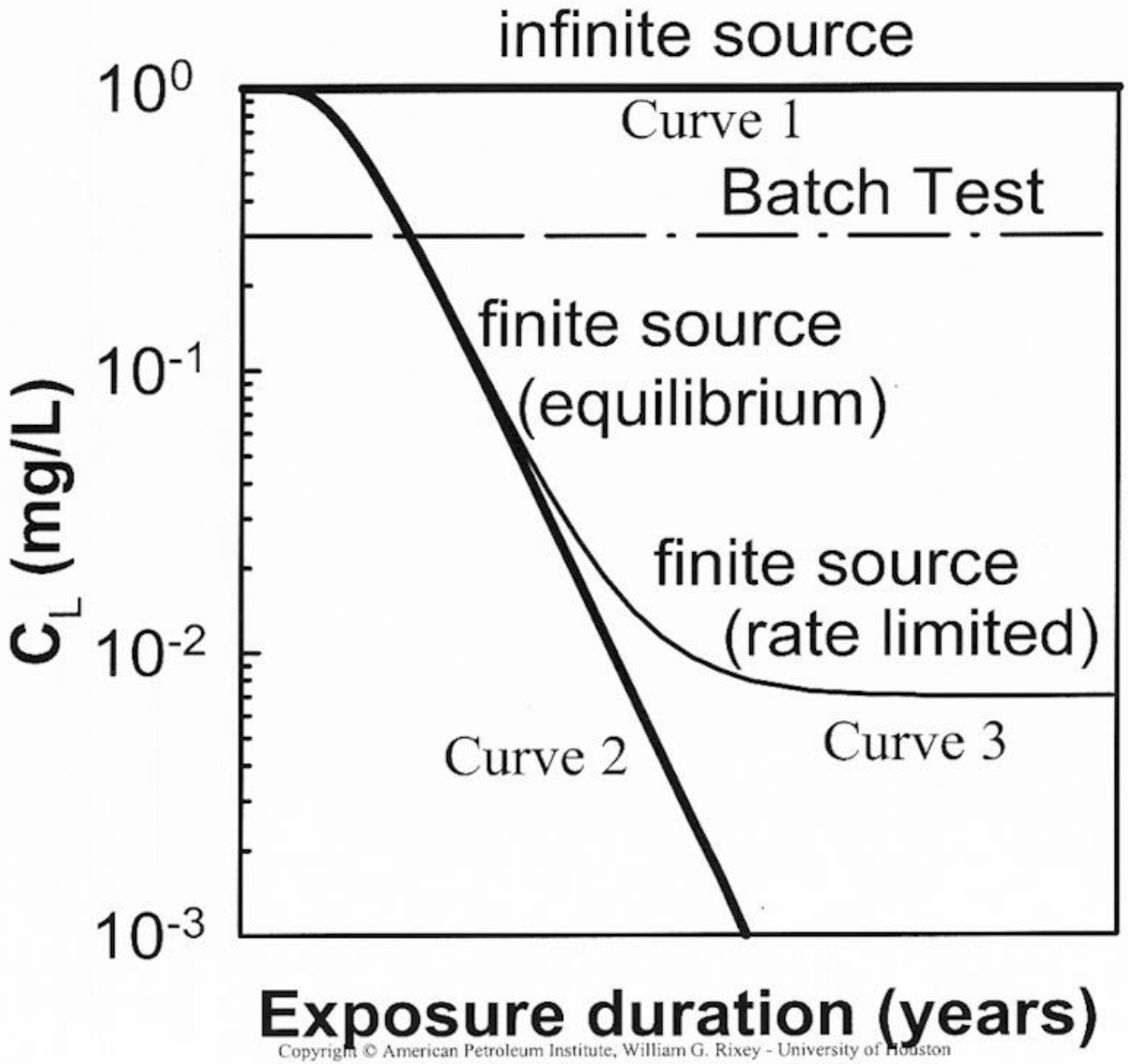


How Do We Determine Acceptable C_L and C_T?

- *Current Approach* - equilibrium partitioning between soil and water. C_L and C_T assumed to be constant over time.

- *Improved Approach* - partitioning between soil, water & residual NAPL, also kinetics and finite source characteristics.

Effect of Finite Characteristics & Kinetics on Source Leachate



Factors That Need to be Incorporated in Leachate Description

- Presence of NAPL residual
- Kinetics - slow release
- Finite Source characteristics
  e.g., temporal changes from losses due to leaching, volatilization, etc.

How do we do that?

- with Source Zone Modeling coupled with groundwater transport modeling using appropriate measured leaching parameters.

Source Zone Modeling

A contaminant mass balance yields:

equil. release — rate-limited release — loss term

$$K_w \frac{dC_L}{dt} + \rho_b \frac{dq_2}{dt} = -\Lambda C_L$$

where:

water — air — **NAPL** — soil — partitioning

$$K_w = \phi \left(S_w + S_a K_H + S_o K_o \right) + \rho_b F K_d$$

avail. fraction

Source Zone Modeling (cont.)

slow rate constant / slow fraction

$$\frac{dq_2}{dt} = k_2 \left[K_d \left(1 - F\right) C_L - q_2 \right]$$

leaching / volatilization / degradation

and $$\Lambda = \frac{u}{L} + \lambda_V + \lambda_D$$

Source Zone Modeling (cont.)

$$C_L(t) = f(\overbrace{K_o, S_o, K_d}^{K_w}, \underbrace{F, k_2}, \overbrace{u/L, \lambda_v, \lambda_D}^{\Lambda})$$

I II III

Obtain from:

I. default values or batch tests coupled with total analyses.

II. rate of release (ROR) tests when necessary.

III. default values or separate tests when necessary.

How can we account for $C_L(t)$?

$$C_{Lo} = DAF * C_R$$

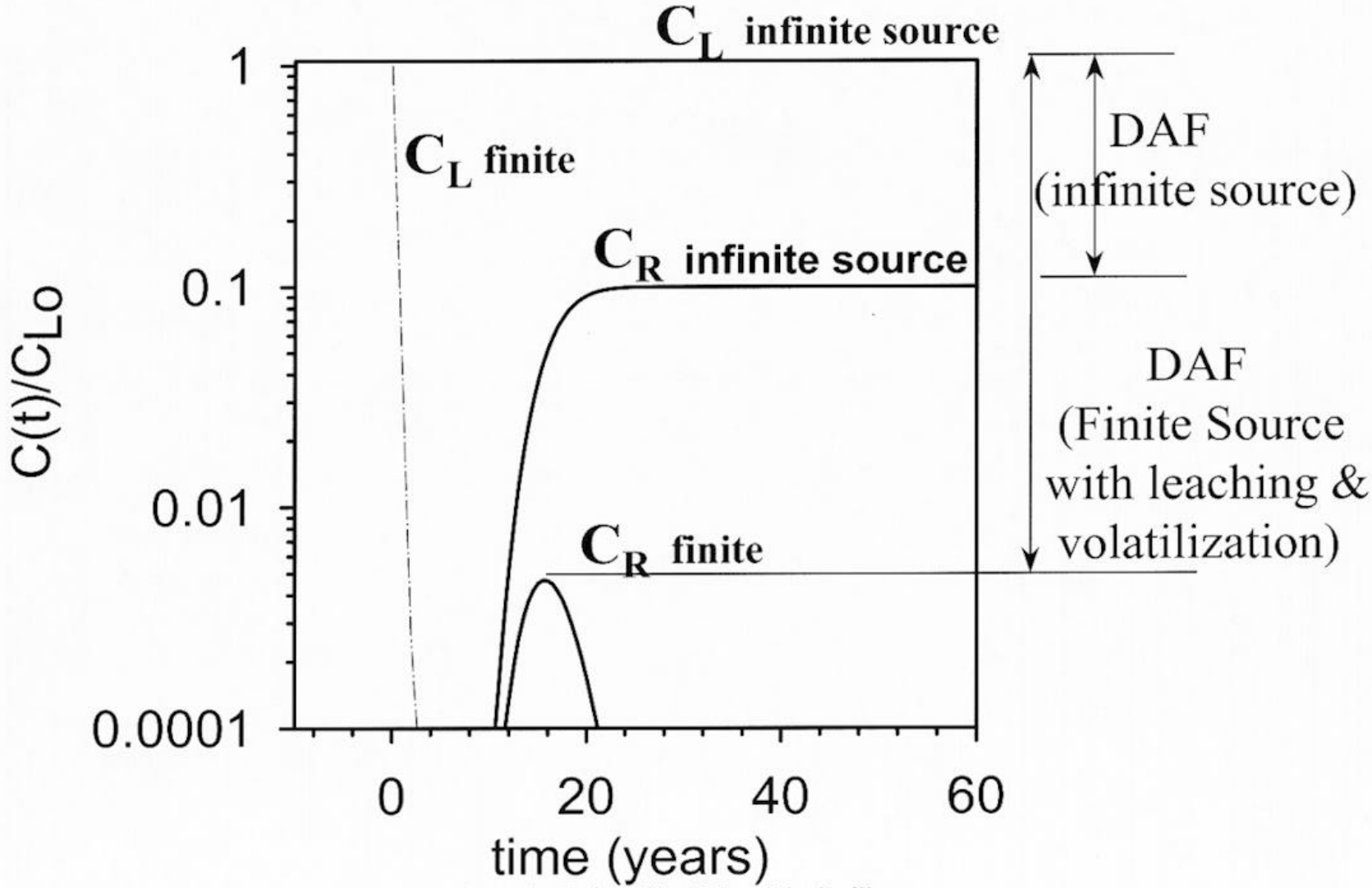
$$DAF = f(K_w, F, k_2, \Lambda;\ u^{GW}, L, R, \lambda_D{}^{GW}, \alpha_x)$$

Source parameters

Groundwater parameters

C_{Lo} = acceptable <u>initial</u> source leachate concentration that incorporates finite source behavior. (can be related <u>quantitatively</u> to a batch test)

Example of Impact of Finite Source on C_R (for fixed C_{Lo})



Where Does a Batch Test Fit In?

- Can be used to get C_{Lo} and K_w, if equilibrium conditions exist.
- For nonequilibrium conditions or when losses (other than leaching) occur, calculations using acceptable default values or separate tests are needed.

Potential Procedure for Determining Acceptable C_L and C_T.

- Batch tests for C_{Lo} and K_w for equilibrium leaching (in the absence of other losses).
- Use separate procedure to measure kinetics when important.
- Use default values or separate tests for volatilization, degradation, etc. when important.
- Use default or measured values in coupled source zone & GW transport model to determine acceptable C_L and C_T values.

Conclusions

- Batch tests can be used to obtain the appropriate equilibrium leaching parameters for organic compounds from oily wastes.
- Separate estimation methods/tests are recommended for accounting for other loss processes, e.g., volatilization and degradation.
- Acceptable default values or separate test methods can be used to account for kinetics when needed.

Other Leaching Modeling Issues

- NAPL migration.
- Lab-to-Field translation.
- Field-scale heterogeneities:
  - soil type
  - contaminant distribution
  - paths for various transport processes, e.g., leaching, volatilization, etc.
- Sampling considerations.
- Parameter statistical uncertainty.