CEE 5680/6680

Conceptual Site Model

* Evaluative Site
* Chemical mass balance and distribution among physical phases
* Flow Diagram to relate source to receptor pathways

Evaluative Sites

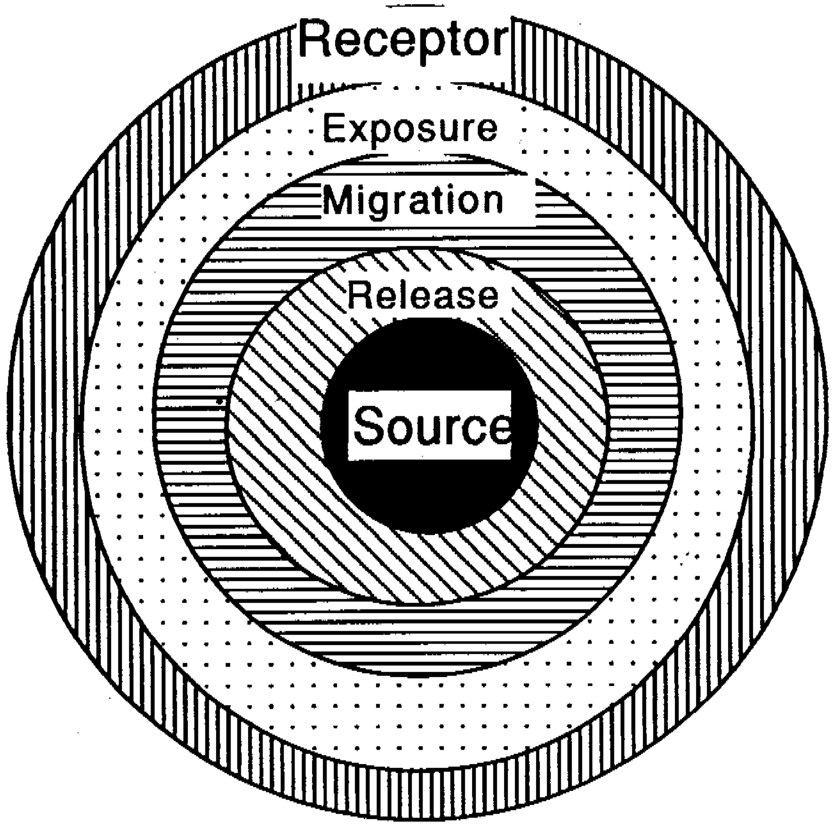
* The evaluator designs a "site," then explores the likely behavior of chemicals in that site
* Can perform a sensitivity analysis of the variables to focus the types of information needed

Mass Balance Approach

* Which phases contain which chemicals (distribution)?
* Where are the phases going (release/transport)?
* What are the exposures to phases (risks to humans and the environment)?
* Which phases to manage?

Flow Diagram

* Incorporates site specific data into evaluative site and mass balance information
* Assists in organizing information for a site
* A communication tool for site owners/operators, regulators, consultants
* Facilitates development of management strategies to protect humans and the environment



Link sources to receptors including humans and the environment

ENGINEERING MANAGEMENT OPTIONS

* Should address each relevant physical phase
* Engineering Options:
(1) Contain (the phase)
(2) Destroy (the chemicals in the phase)
(3) Extract (the phase)

Problem Statements and Decision Rules

Problem Statement: Address a phase with respect to human or environmental exposure

Example: Lead in present in the top soil at concentrations exceeding the target cleanup level for protection of human health.

Decision Rule: An "if, then" statement that identifies possible responses to a problem(s).

Example: If Lead is present in the top soil at concentrations that exceed the target cleanup level (for protection of human health), then the soil will excavated and hauled to a certified hazardous waste treatment/disposal facility.

Evaluative Sites final comments

* Used to assess chemical distribution, fate, and transport from source to receptor using realistic site properties including physical phases and volumes, waste composition, and components that may not be complete or that can be estimated

* Using minimal data requirements, can focus investigation on characterization needs and potential interim or final corrective actions

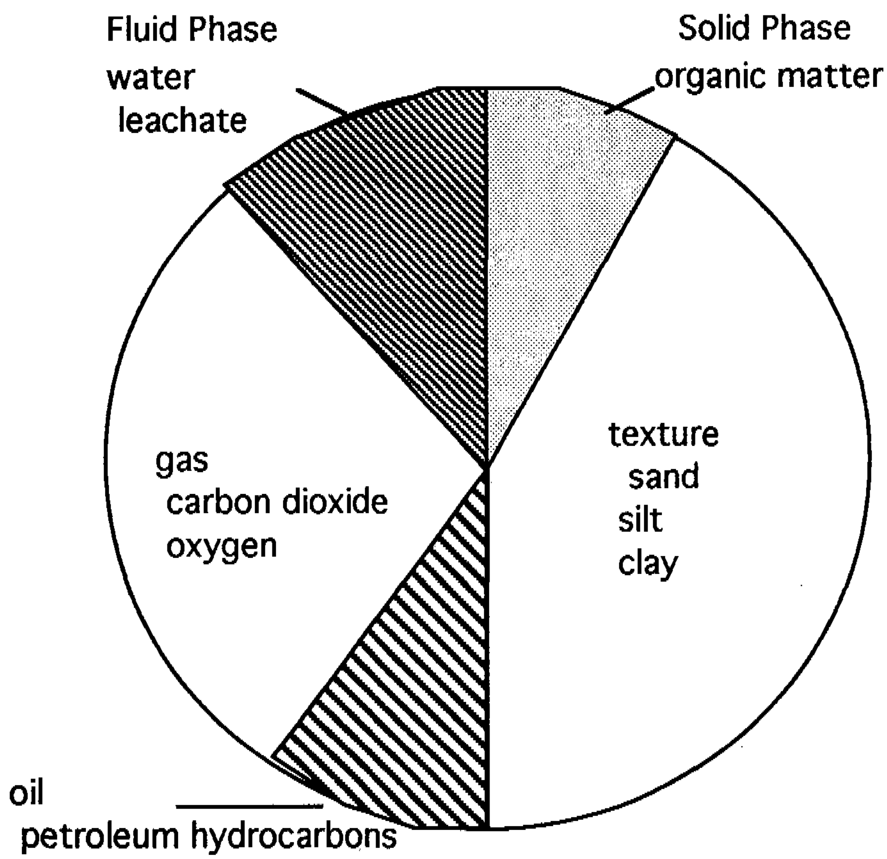
* When the patterns of chemical distribution are established, it is logical to describe in more site-specific detail the media that are important for that chemical

Notes:

The concept of "evaluative environments" was introduced by G.L. Baughman and R.R. Lassiter in 1978 and presented in the publication "Estimating the hazard of chemical substances to aquatic life." J. Cairns, Jr., K.G. Dickson, A.W. Maki, eds., American Society of Testing and Materials Technical Publication 657, Philadelphia, PA.

Evaluative aquatic environments were also used to develop the U.S. Environmental Protection Agency (EPA) EXAMS model of chemical fate in rivers and lakes.

Mass Balance Conceptual Approach to Methodology



Chemical mass balance approach to soil and contaminants associated with reserve pit waste materials/soils.

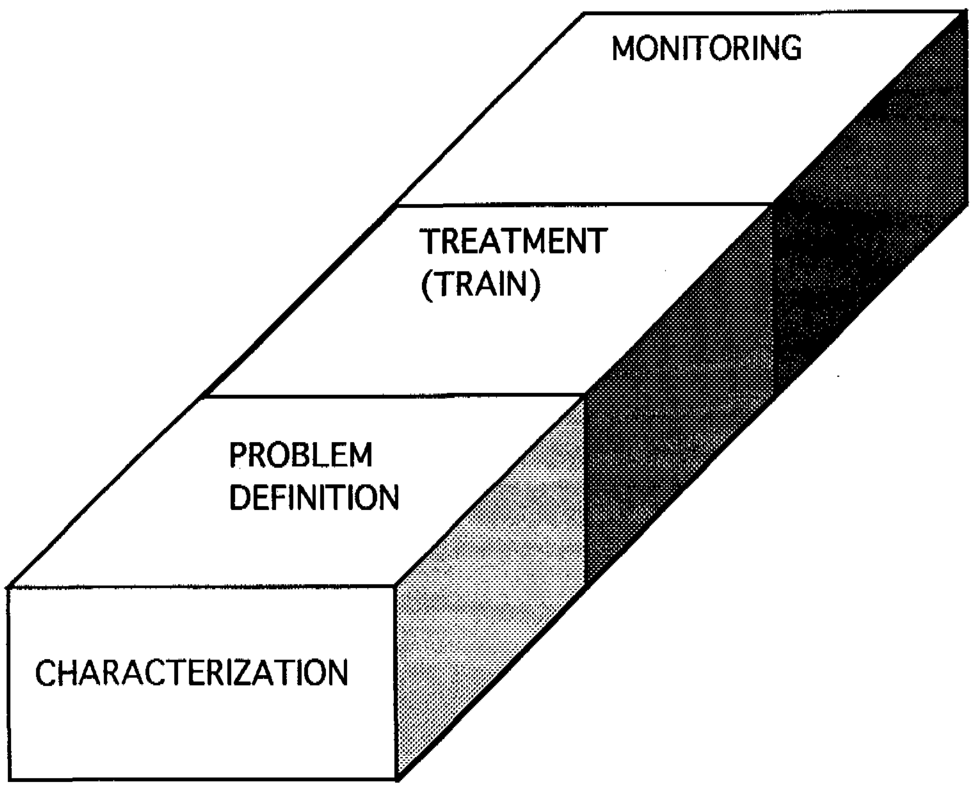
Solid Phase contains solid components of soil/waste mixture
(1) organic matter
(2) texture, i.e., sand, silt, and clay components

Fluid Phase contains components that can flow
(1) oil or petroleum hydrocarbons
(2) gases, generally including carbon dioxide and oxygen
(3) water or leachate

TECHNICAL APPROACH

* Engineering Technologies
  - Evaluating
  - Selecting (also eliminating)

* Methodology to follow
  - Characterization - Match
    - (1) Chemical characteristics with
      (2) Site characteristics
  - Problem Definition
    - (1) Exposure
      (2) Escape
      (3) Containment
  - Treatment (Technologies) Alternatives = f( )
    (1) Phase
    (2) Chemical
  - Monitoring (for each Technology)
    (1) Phase
    (2) Chemical



Cover reading #6

see table 3 in reading#3

CHARACTERIZATION:

Where is the contamination and in what form(s) does it exist?
Translation - What are the chemicals?
What are the phases?
Which chemicals in which phases?
Where are the phases?

Quantitative Evaluation of Mass Balance
I. Partition Coefficients
II. Fugacity

I. PARTITION COEFFICIENTS - more details in textbook (SSSA)

Kd = Cs/Cw = Conc. in soil phase/Conc. in water phase

$$= \frac{mg/Kg}{mg/L} = \frac{mg}{Kg} \times \frac{L}{mg} = L/Kg$$

$$= \frac{mg/Kg\ soil}{mg/Kg\ water} \text{ (unitless)}$$

Koc = Kd/f_{oc} = Kd/fraction of organic carbon in soil

Ko = Co/Cw = Conc. in oil phase/Conc. in water phase

$$= \frac{mg/Kg}{mg/Kg} \text{ or } \frac{mg/L}{mg/L}$$

Henry's Law:P/S

$$= \frac{\text{vapor pressure}}{\text{solubility}} = \frac{atm}{mole/m^3} = atm\text{-}m^3/mole$$

Kh = Ca/Cw = Conc. in air phase/Conc. in water phase

(1) **H,** Henry's Law is often used for Kh

(2) $\frac{\textbf{moles/m}^3\textbf{ air}}{\textbf{moles/m}^3\textbf{ water}}$ **(unitless)**

(3) **H/RT** $= \frac{atm\text{-}m^3/mole}{(atm\text{-}m^3/mole\text{-}^oK)\ ^oK}$ (unitless)

Raoult's Law: $C_w = X_0 S_w$

where C_w is the chemical concentration in the aqueous phase (moles/L) in equilibrium with the organic phase, X_o is the mole fraction of the chemical in the organic phase, and S_w is the aqueous solubility of the chemical (moles/L).