

**Pharmaceuticals in Water:  
Reducing Uncertainty and Unknowns in  
*Exposure Assessment***

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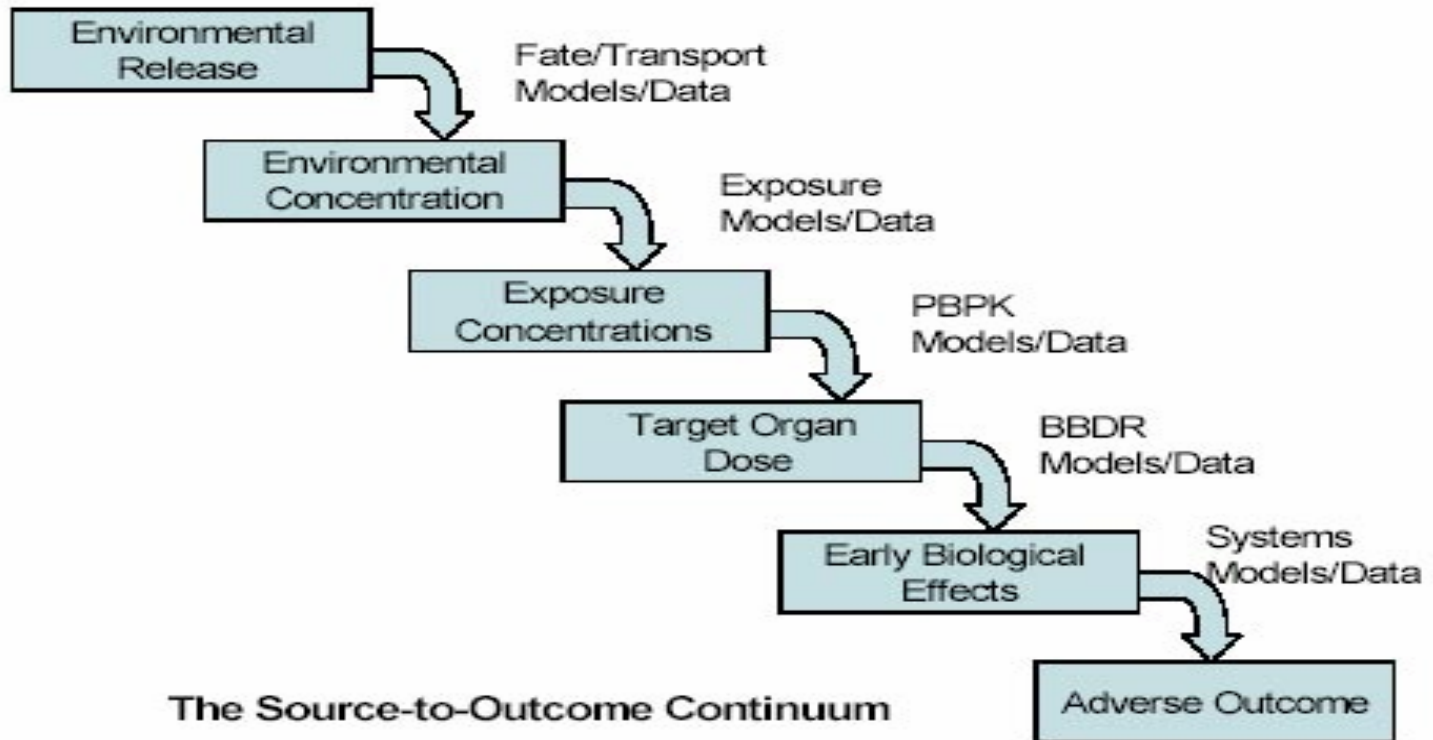
**d\_shea@ncsu.edu**

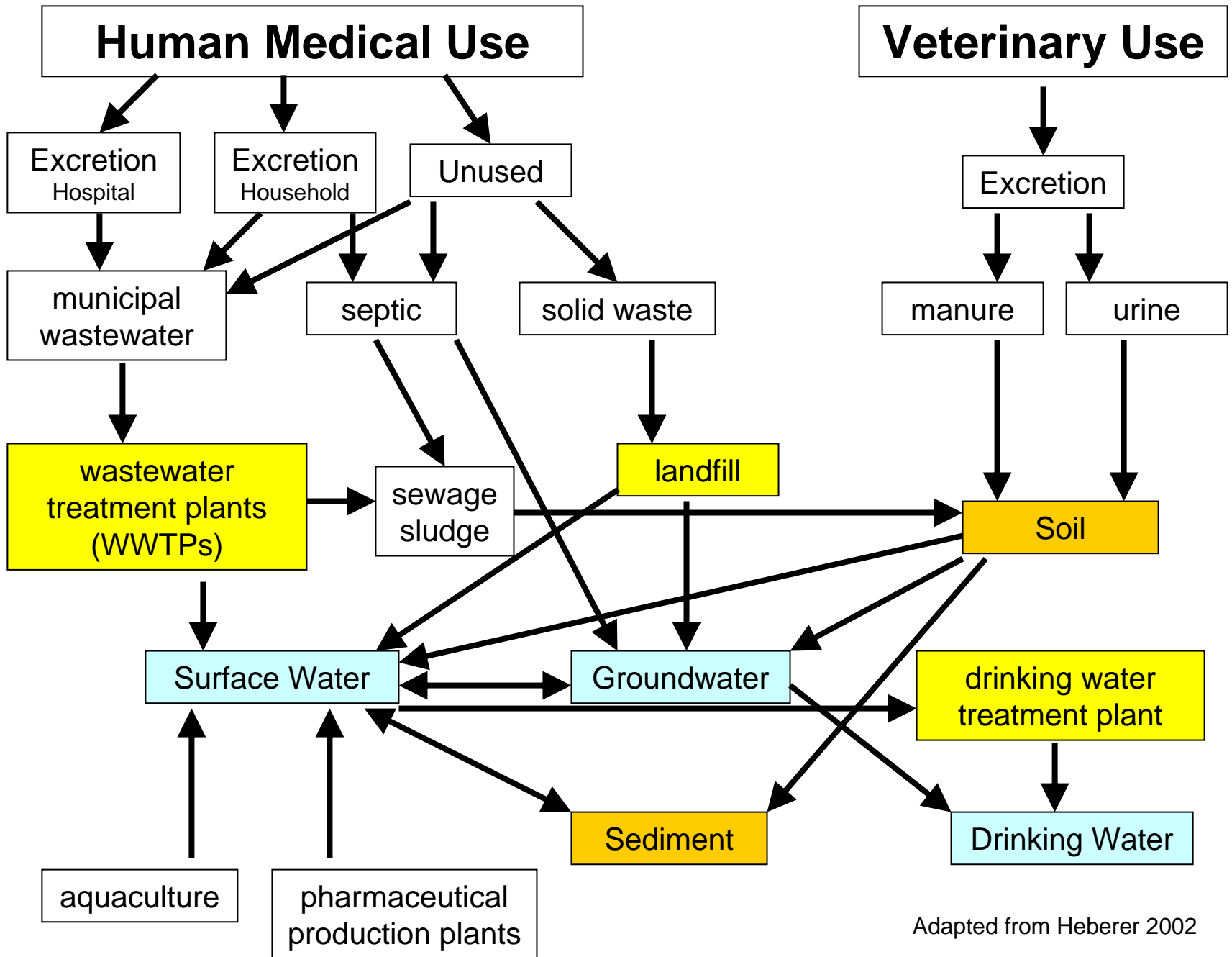
### Transport and Fate Model

Environmental Factors that Modify Exposure

### Exposure-Response Model

Toxicant Source(s) ↔ Toxicant Exposure ↔ Toxicant Effects





# Exposure Assessment Challenges

## Pharmaceutically Active Form and Relative Activity?

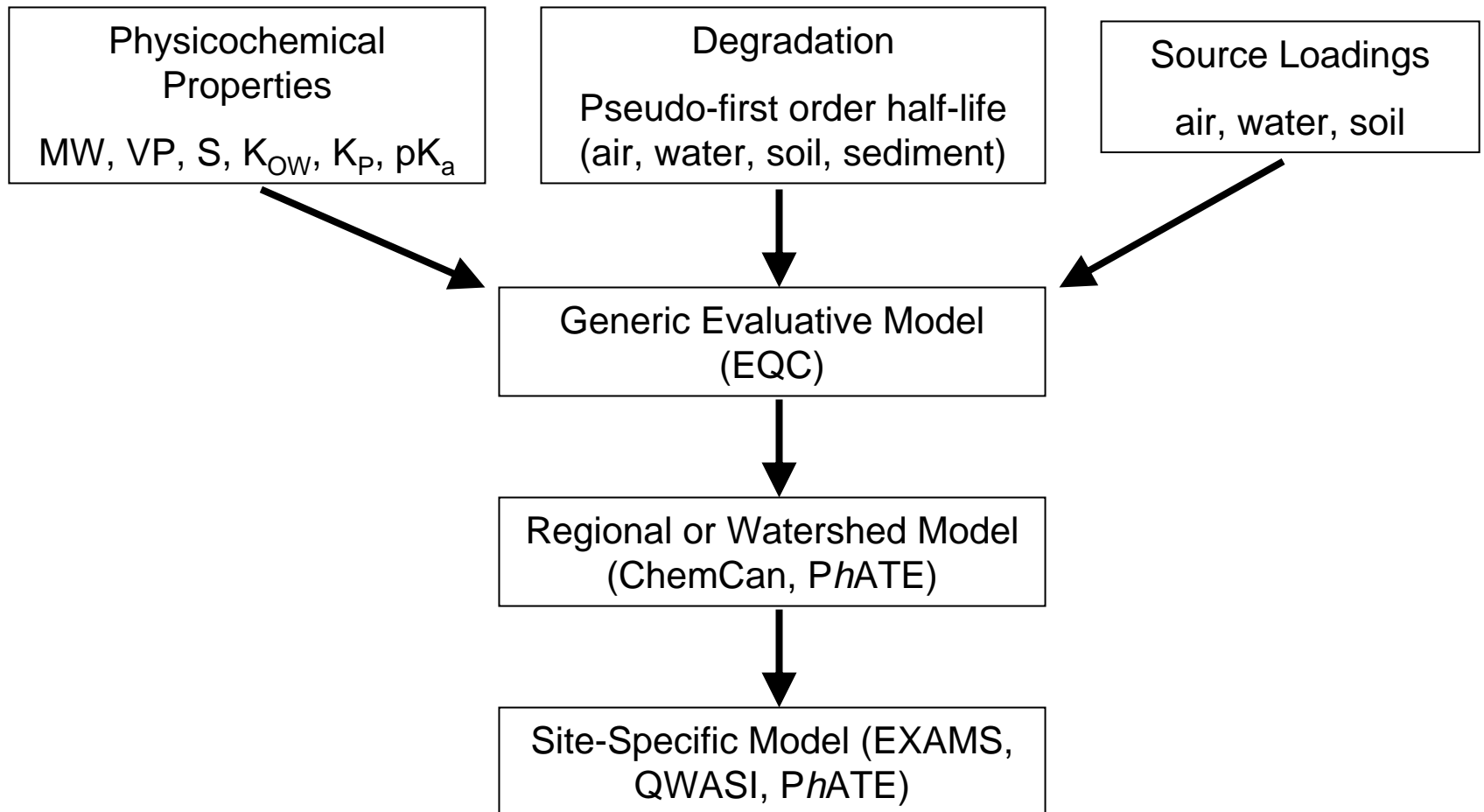
- Parent chemical
- Phase I metabolites (e.g., redox, hydrolysis)
- Phase II metabolites (conjugation)
- Disinfection byproduct
- Complex mixture of parent and metabolites

## Bioavailable Form?

- Freely dissolved
- Colloidally bound (DOC)
- Particle bound

# Exposure Assessment Challenges

## Modeling Transport and Fate



# Exposure Assessment Challenges

## Measuring Exposure – Sampling Issues

### Acute versus chronic exposure

grab or composite samples, integrative sampling (TWA)

### Environmental compartment or matrix

water, sediment, soil

### Temporal variability and resolution

### Spatial variability/trends and resolution

### Methods (preservatives, holding times, etc.)

# Exposure Assessment Challenges

## Measuring Exposure – Analytical Issues

### Sensitivity and method detection limit (MDL)

What concentration is biologically relevant?

### Multi-residue methods (cost, throughput)

### Selectivity and identification

Matrix interferences, false positives and negatives

Sample cleanup and fractionation

GC and LC, MS versus MS/MS

### Performance-based methods

### Quality assurance and control

## Reducing Uncertainty and Unknowns in Exposure

What chemicals / metabolites make “the list”?

- Use rates, measurements, models
- Biologically active forms and activity

Modeling for screening risk assessment

- Source loadings, physicochemical properties, degradation rates, partitioning

Measurements of exposure and emissions

- Acceptable/preferred methods (grab vs TWA, cleanup, MS vs MS/MS, MDLs, QC)
- Spatial and temporal resolution