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# Quality Site Assessments & Investigations Using the Conceptual Site Model Approach

# PART II: SITE INVESTIGATION

## Testing the CSM

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Tighe&Bond

# SITE INVESTIGATION WORK PLAN - CSM

## Develop the Initial CSM

"The CSM is a site-specific description of how contaminants entered the environment, how they have been and may be transported within the environment, and routes of exposure to human and environmental receptors…"

## The CSM is a Dynamic Framework for:

- Identifying and addressing data gaps and managing uncertainty
- Eliminating or controlling contaminant sources
- Developing and conducting response action strategies
- Evaluating whether response actions have achieved desired endpoints

# SITE INVESTIGATION WORK PLAN - CSM

## Develop the Initial CSM

- **Summarize Known and Hypothesized Information - Visual, Descriptive**
  - Location of RECs, AOCs, Sudden Releases, etc.
  - On-site features or processes that could exacerbate RECs, AOCs, etc.
    - Infrastructure details
  - Identify/hypothesize Contaminants of Potential Concern (COPCs)
  - Evaluate anticipated contaminant behavior in the environment
    - Mobility, density, volatility, biodegradability
  - Geology
  - Groundwater flow direction
  - Surface Runoff Patterns
  - Hypothesize extent of contamination
    - Vertical and horizontal extent
  - Nearby sensitive receptors (potable/supply wells, indoor air, reservoirs, endangered species)

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Exposure Pathway

An *exposure pathway* is the link between a contaminant source and a receptor (U.S. EPA, 1991). A complete exposure pathway is one in which the stressor (aka agent) can be traced or expected to travel from the source to a receptor that can be affected by that stressor (U.S. EPA OSWER, 1997).

**Pathways: Groundwater, drinking water, indoor air, surficial soil**

**Stressors: Any chemical, biological entity, or physical disturbance that can induce an adverse response**

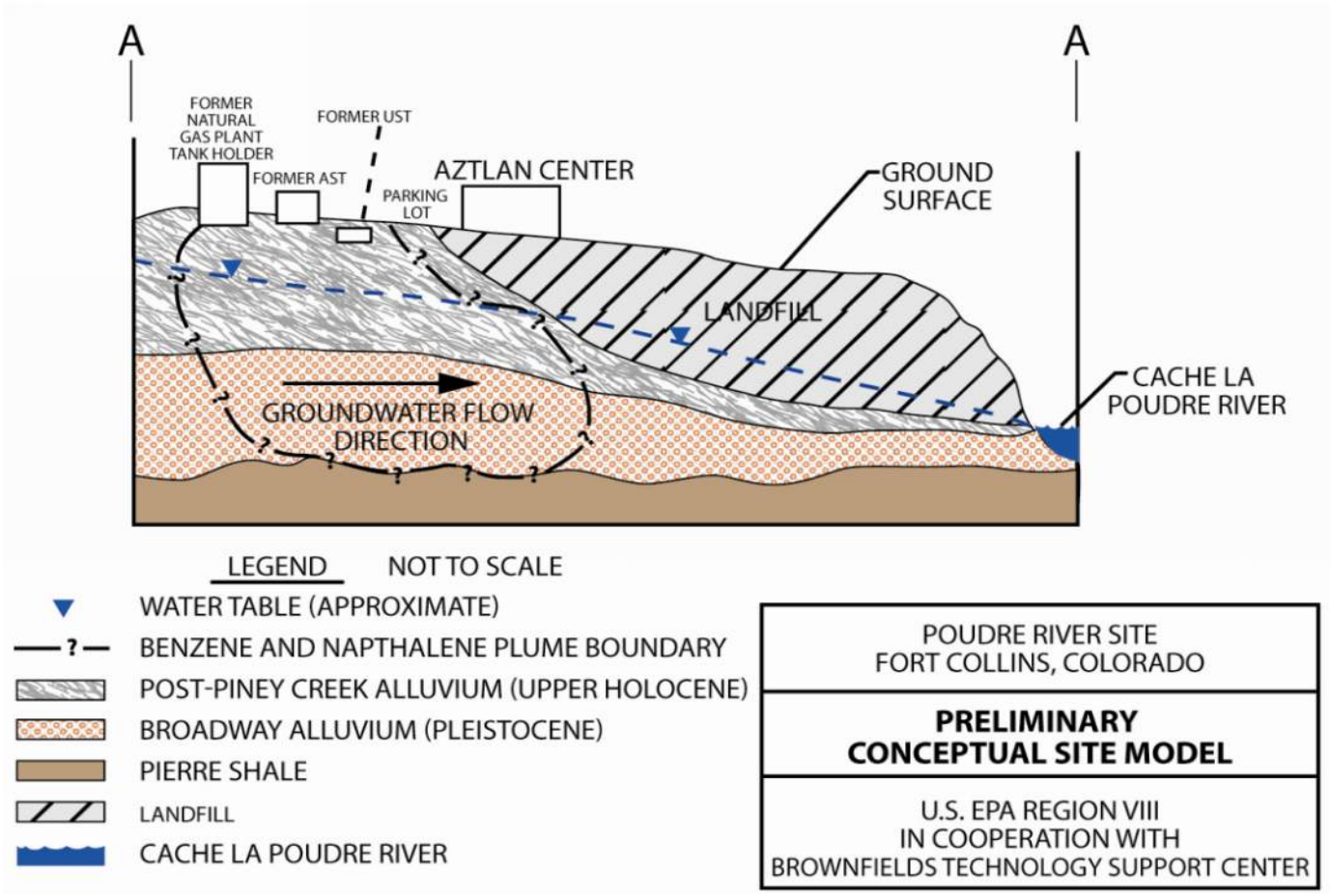
## Exposure Route

An *exposure route* is the way a chemical, physical or biologic agent enters our body (Source: Boston University)

**3 Major Human Exposure Routes: Ingestion, inhalation, dermal absorption**

# SITE INVESTIGATION WORK PLAN - CSM

## Develop the Initial CSM




Source: USEPA ***Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model***

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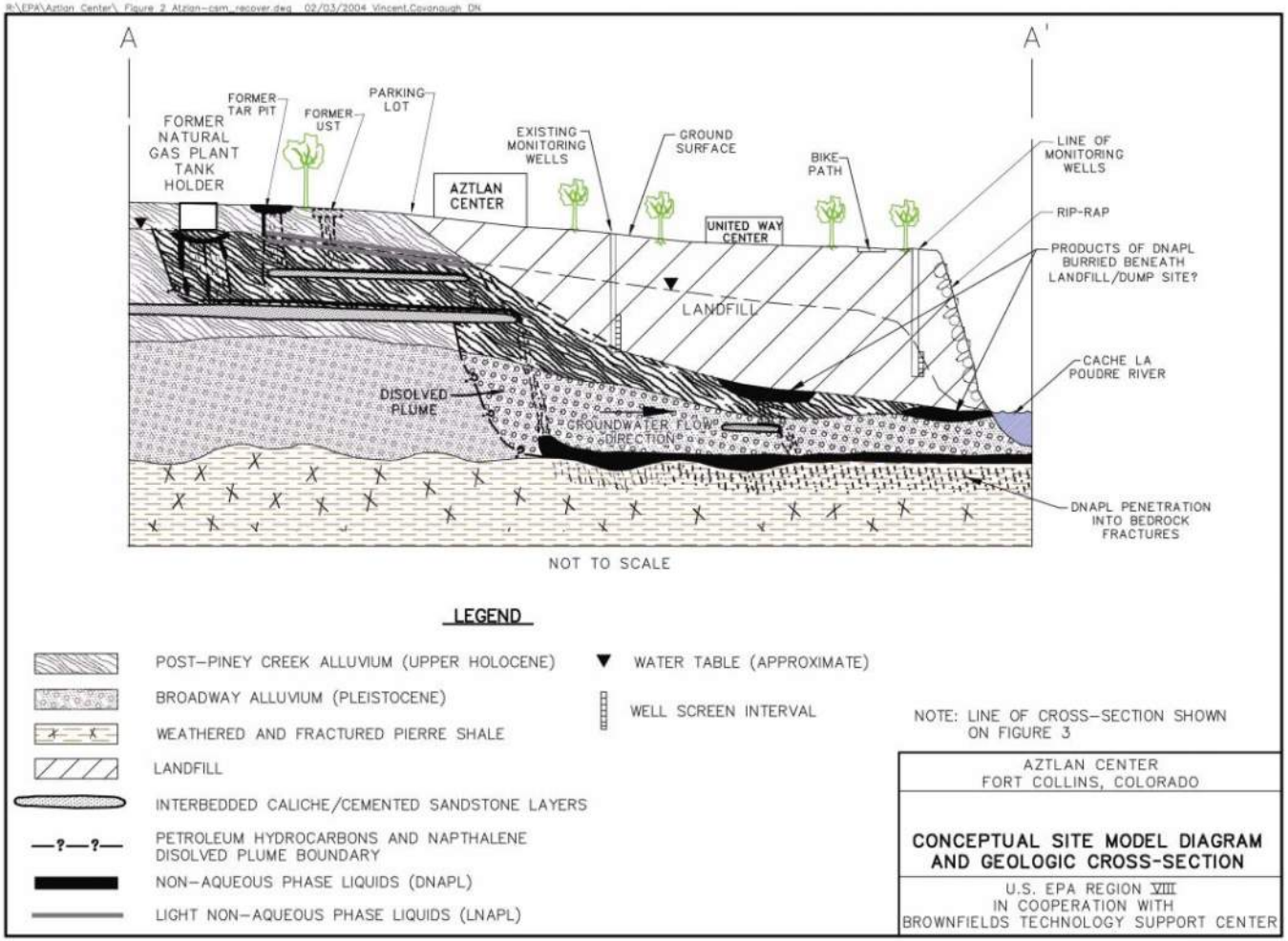
# SITE INVESTIGATION WORK PLAN - CSM

## Updating the CSM




Source: USEPA ***Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model***

# SITE INVESTIGATION WORK PLAN - CSM

## Develop a Work Plan Based on The CSM

- **Start with the End in Mind**
  - Connect the source areas to receptors
  - Identify potential site uses and exposure pathways requiring evaluation
  - Evaluate/build on existing data
  - Design a workplan that provides useful data for risk characterization
- **Consult Quality Assurance Plans and Standard Operating Procedures**
  - Regional EPA QAPP Procedures - Brownfields
  - NHDES QAPP documents (Petroleum Sites and Haz Waste Sites)
  - Industry or company-specific SOPs (Decontamination procedures, HASP, engineering controls)
- **Develop an Initial Site Sketch**
  - Existing physical site features identified in CSM
  - Receptors (potable/supply wells, indoor air, surface waters)
  - Proposed sample, boring, monitoring well locations
    - "Scope and detail commensurate with release(s) and site conditions"

# SITE INVESTIGATION WORK PLAN - CSM

## Develop a Work Plan Based on The CSM (cont'd)

- **Consider Potential Anthropogenic Influences**
  - Potential groundwater mounding from septic/stormwater infiltration
  - Abandoned building foundations and footings
  - Preferential pathways from utility gravel beds
  - Cutting and filling
  - Historical fill
- **Identify Analyses Required**
  - Data sensitivity and risk characterization needs
  - Microscopy analysis (lead, asbestos)

# TESTING THE CSM

## Potential Exposure Pathways

### Air Pathways

- Outdoor/ambient air
- Indoor Air (vapor intrusion)

### Groundwater Pathways

- Direct Consumption (drinking, cooking)
- Dermal Absorption (bathing)
- Inhalation (bathing)

### Soil Pathways

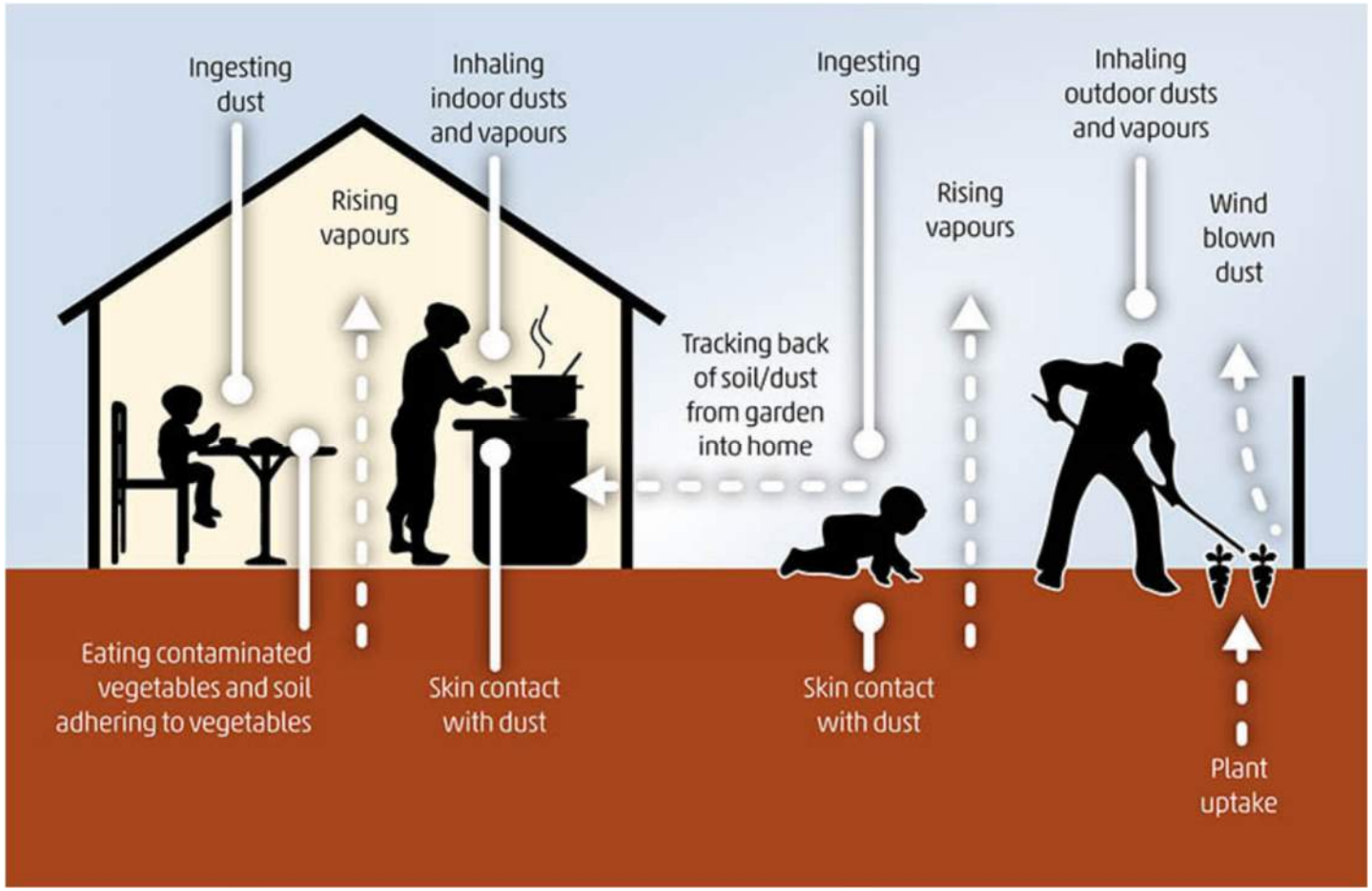
- Dermal Absorption (recreation)
- Incidental Ingestion (construction)
- Inhalation of Particles (construction)
- Produce (agriculture/gardening)
- Soil Gas (vapor intrusion)

### Surface Water Pathways

- Dermal Contact (recreation)
- Incidental Ingestion (recreation)

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Soil




Source: ***United Nations Environmental Assembly:*** **Chapter 4. Environmental, health and socio-economic impacts of soil pollution**

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Soil Exposure Pathway

- Direct contact with soil is the primary concern
- Exposure pathways are categorized based on soil contaminant accessibility to receptors
- Exposure routes include dermal absorption, incidental ingestion, dust inhalation

### Surficial Soil

- Considered “accessible” in most cases (top 3 feet)
- Typically residential activities (passive recreation, gardening, home produce)
- Majority of ecological exposures are in the top 2 feet

### Soil “at Depth”

- Considered “potentially accessible” or “inaccessible” (below 15 feet)
- Typically associated with construction activities (excavations, utility work)
- Can become “surficial” soil if cutting/filling occurs in the future

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

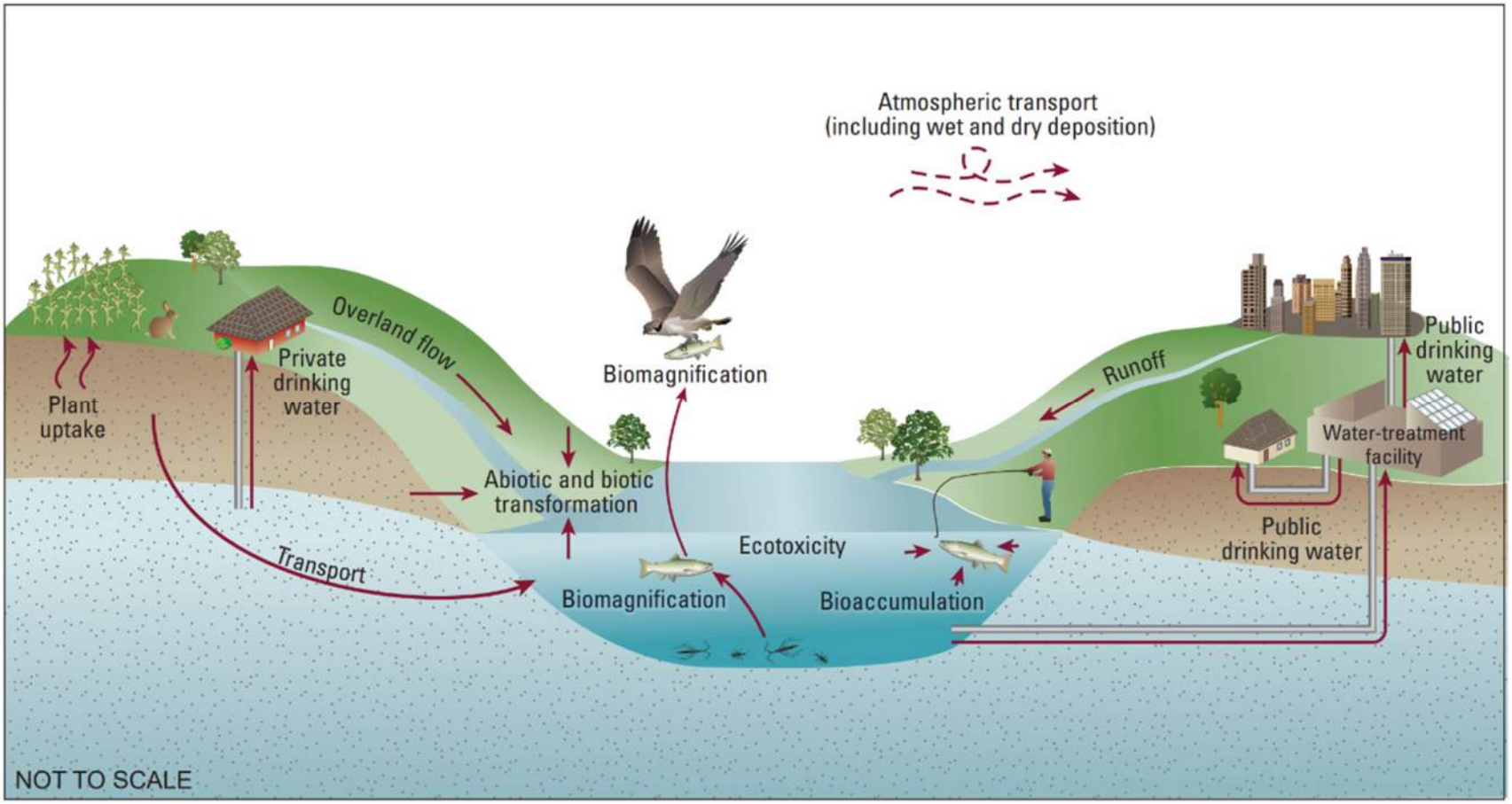
## Soil Exposure Pathway Assessment

### Soil Sampling

- Hand tools for surficial soil
- Soil borings for deep assessment
  - Geoprobe is economical, but compression can cause uncertainty in sample depths
  - Hollow-stem auger is slower, but gives more precise sample depths
- Field screening techniques available (TPH, Total VOCs)
  - Guides assessment (vertical, horizontal) and analytical sample selection
- Match sample depths to exposure pathways ( e.g. 0-3 feet, > 15 feet)
- Avoid spanning exposure categories (e.g. 2-4 feet)

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Groundwater




Source: ***USEPA:*** **Improving Understanding and Coordination of Science Activities for Per- and Polyfluoroalkyl Substances (PFAS) in the Chesapeake Bay Watershed**

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Groundwater Exposure Pathway

- Direct consumption (GW-1)
- Vapor Intrusion (GW-2)
- Recreational and Ecological

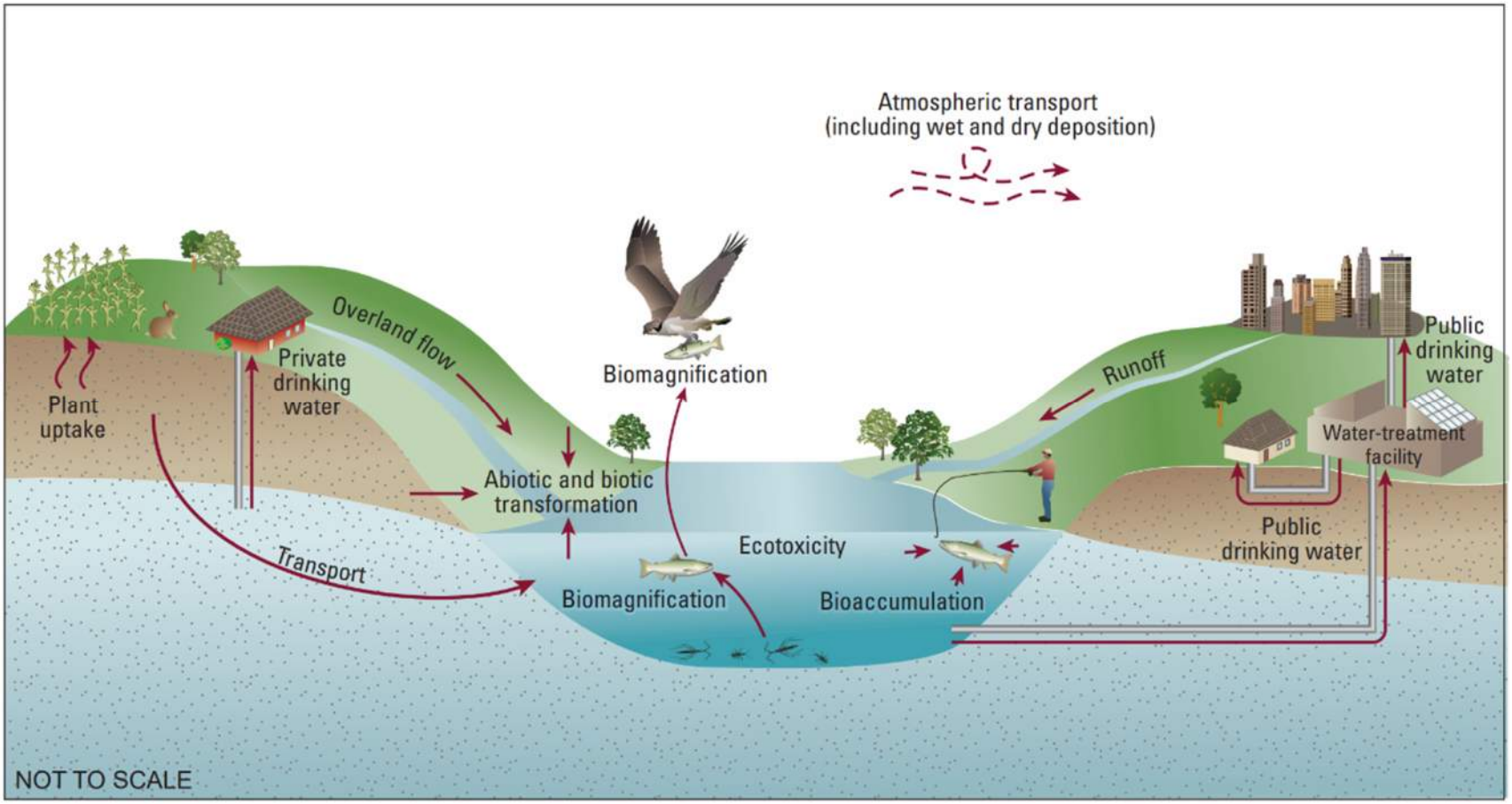
# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Groundwater Pathway Assessment

- Characteristics of contaminant being assessed
- Design of monitoring well network (source area, mid-plume, edge of plume)
- Temporary well / permanent well
- Well development (reduce turbidity)
- Bailer or low-flow sampling
- Sample integrity:
  - Keep sampling area clean, use poly sheeting
  - Wipe down containers with paper towels
  - Place containers in bubble wrap, storage bag and place in cooler with cold source
  - Laboratory prepared sample containers appropriate for analysis requested
  - Cooler temperature (if using ice protect against melt water and cross contamination)
  - Chain-of-Custody, Blanks, Duplicates, etc.

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Sediment and Surface Water

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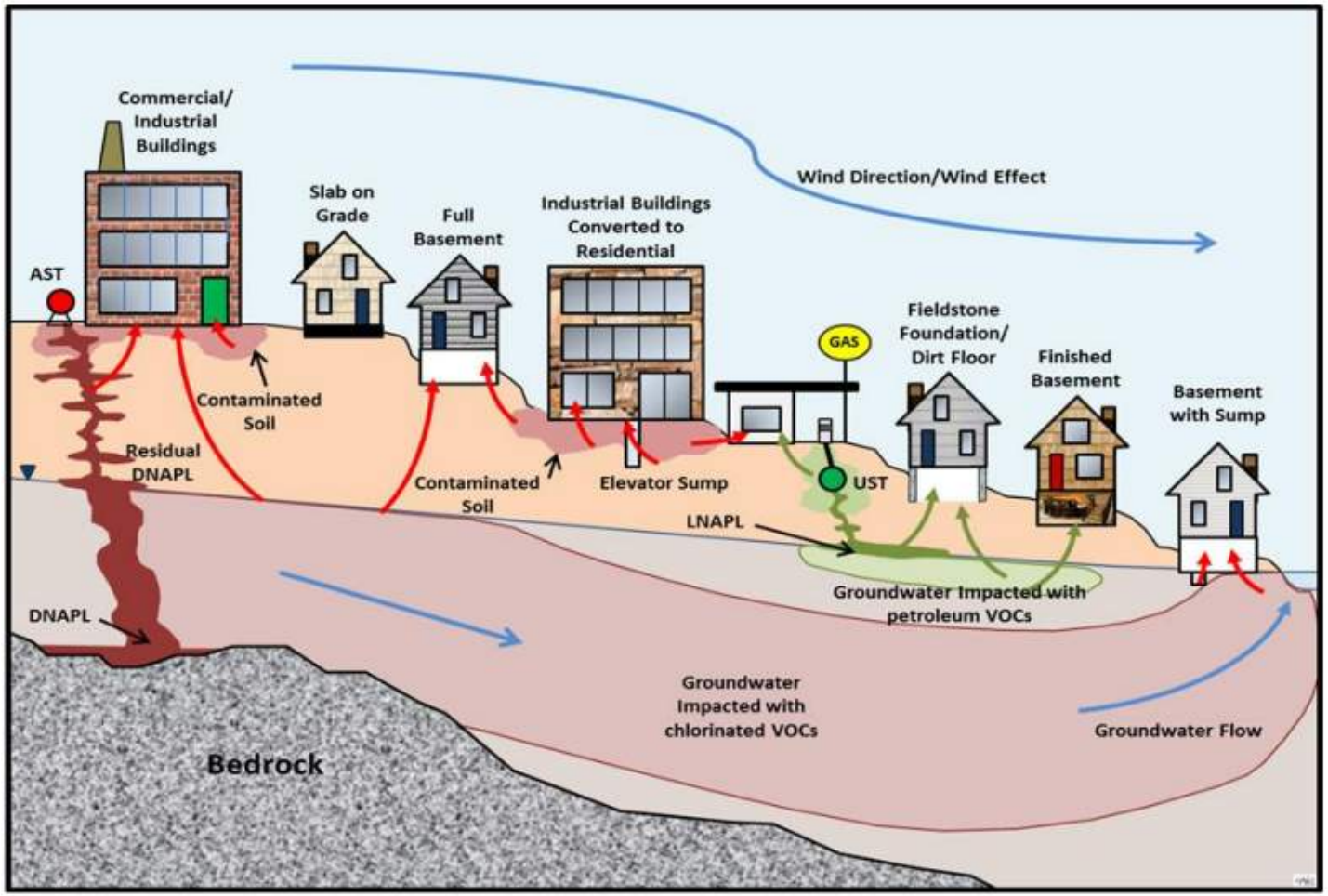
# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Air




Source: MassDEP *Vapor Intrusion Guidance: Site Assessment, Mitigation and Closure Policy #WSC-16-435*

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Air Exposure Pathway

- Volatile substances
- Vapor intrusion is often the primary concern
- Begin with soil, groundwater and sub-slab soil vapor assessment (NHDES, VI Guidance)

### Soil Vapors

- Vadose zone VOC source are located near a building
- Significant preferential pathway exists – connecting VOC source to nearby building
- LNAPL is located near a building

### Groundwater Vapors

- Chlorinated VOCs in groundwater > GW-2 levels w/in 100’ of occupied building building
- Petroleum VOCs in groundwater > GW-2 levels w/in 30’ of occupied building building

# TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

## Air Exposure Pathway Assessment

**Sub-Slab Soil Gas Sampling**

- Concentrations are variable over short distances
- "Air-Tight" is important (water dams, counter-sunk vapor pins, helium shrouds)
- Applicable thresholds indicate need for indoor air sampling

**Indoor Air Sampling**

- Remove confounding sources (notify ahead of time)
- Create "representative" environment (open windows in summer, closed in winter)
- Applicable thresholds indicate need for risk characterization

**Considerations**

- Seasonality ("winter" conditions: Indoors 10°F > outdoor temperature)
- Preferential pathways/concentration gradient (heating/cooling air movement in building)
- "Other" sources - heated water from contaminated private well
- Confounding indoor sources (moth balls, brake/carburetor cleaners)

# TESTING THE CSM – OTHER CONSIDERATIONS

- Purpose of Sampling – absence / presence determination
- Long Term Monitoring
- Groundwater / Surface Water interaction
    - gaining stream or losing stream
- Continually update the CSM with new data

# TESTING THE CSM – DATA QUALITY OBJECTIVES

- **Definition:** *Data quality objectives (DQOs) are qualitative or quantitative statements developed by the data user to specify the quality of the data needed from a particular activity to support specific decisions.*
- **Standard:** DQOs must be in conformance with professional standards and agency requirements and consistent with known information about the site and its environs.
- **DQOs are the starting point in designing a sampling program.**

  Matches sampling and analytical capabilities to the data targeted for specific uses and ensures that the quality of the data meets project requirements.
- **General DQOs include the following:**
  - To produce an accurate description of conditions at the site.
  - To allow an objective assessment of exposure pathways and risks to receptors.
  - To evaluate the risk to human health and the environment in accordance with current regulatory standards, (e.g., detection limits must be sufficiently low to compare to the regulation or statute that governs the sampled media).

# TESTING THE CSM – DQO'S

- **General DQOs (cont'd):**
  - To establish long-term trends in contaminant levels to support future site management decisions.
  - To evaluate the effectiveness of a treatment system or other remedial strategy.
    - Long-term groundwater monitoring (LTM) is a common remedial alternative for many sites.
      - Verify that groundwater containing COPCs in excess of the remediation goal concentrations does not migrate past the Groundwater Management Zone (GMZ) or other compliance boundaries.
      - Verify reductions in COPC concentrations, on-going natural attenuation processes are reducing the plume, and plume attenuation rates.

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# Questions?