Defining Achievable Remediation

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Consortium for Risk Evaluation with Stakeholder Participation (CRESP)

CRESP

Consortium for Risk Evaluation with Stakeholder Participation*

.......working to advance cost-effective cleanup and greater stakeholder understanding of the nation's nuclear weapons production facility waste sites by improving the scientific and technical basis of environmental management decisions. (www.cresp.org)

Task Groups

Data Characterization, Analysis and Statistics	**Ecological Health**	**Exposure Assessment**	**Health Hazard Identification**
Outreach and Communication	**Remediation and Technology**	**Social, Landuse, Demographics and Geography**	**Worker Safety and Health**

* CRESP is a cooperative agreement with the Department of Energy

Alternative Basis for Remediation Endpoints

- Technical feasibility
- Residual risk
- Background levels
- Regulatory standards

Time, Costs, Risk Reduction and Resource Protection

CRESP Studies
(Examples)

- Statistical evaluation of background groundwater quality at SRS
- Remediation process design and end-point evaluation considering mass transfer limitations (C-BRP TCE plume remediation)
- Integrator Operable Units

Statistical Evaluation of Background Groundwater Quality at SRS

Objective: Define background concentrations for constituents of interest in water table aquifer at SRS

Approach:

- Statistical characterization of historic groundwater monitoring data
- 17 constituents of interest based on DOE and EPA input
- Use GIMS database; ca. 70,000 observations considered
- Define background concentration probability distributions and spatial distributions

Expected Result:

- Eliminate redundant monitoring and analysis
- Assist in the definition of remediation end-points

Flow Diagram for Statistical Evaluation of Groundwater Constituents based on GIMS database (Inserted)

Example Kriged Map of SRS indicating likely background areas for trituim (inserted)

Remediation Process Design and End-point Evaluation Considering Mass Transfer Limitations

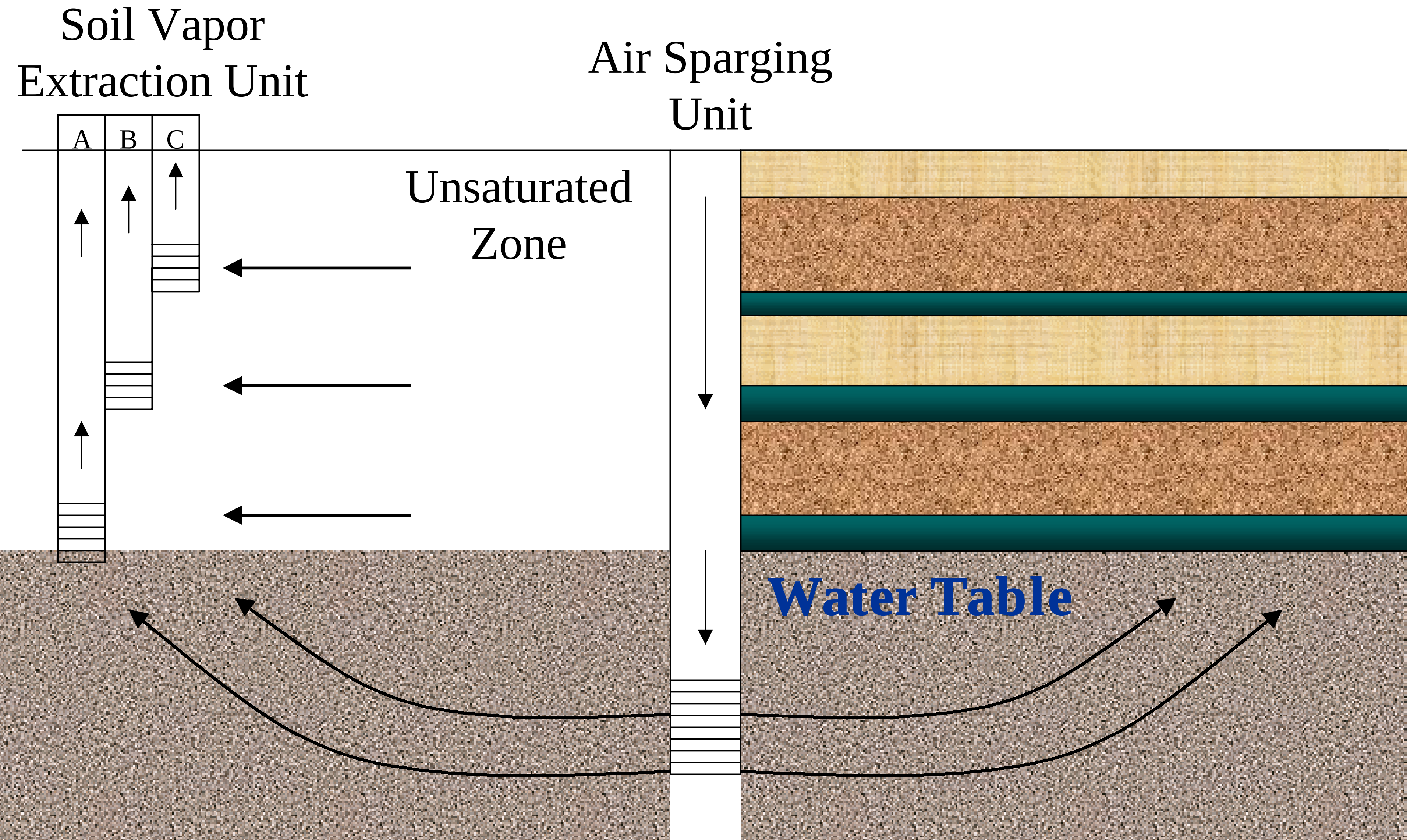
Objective: To include fundamental understanding of mass transfer limitations due to soil pore structure and heterogeneity in remediation models

Approach: Laboratory and theoretical studies followed by model application and validation based on C-area Burning/Rubble Pit trichloroethylene (TCE) plume remediation

Expected Results:

- More efficient remediation process design and operation
- Definition of remediation end-points which are both protective and practical

Conceptual Diagram of the Soil Vapor Extraction and Air Sparging (SVE/AS) Process



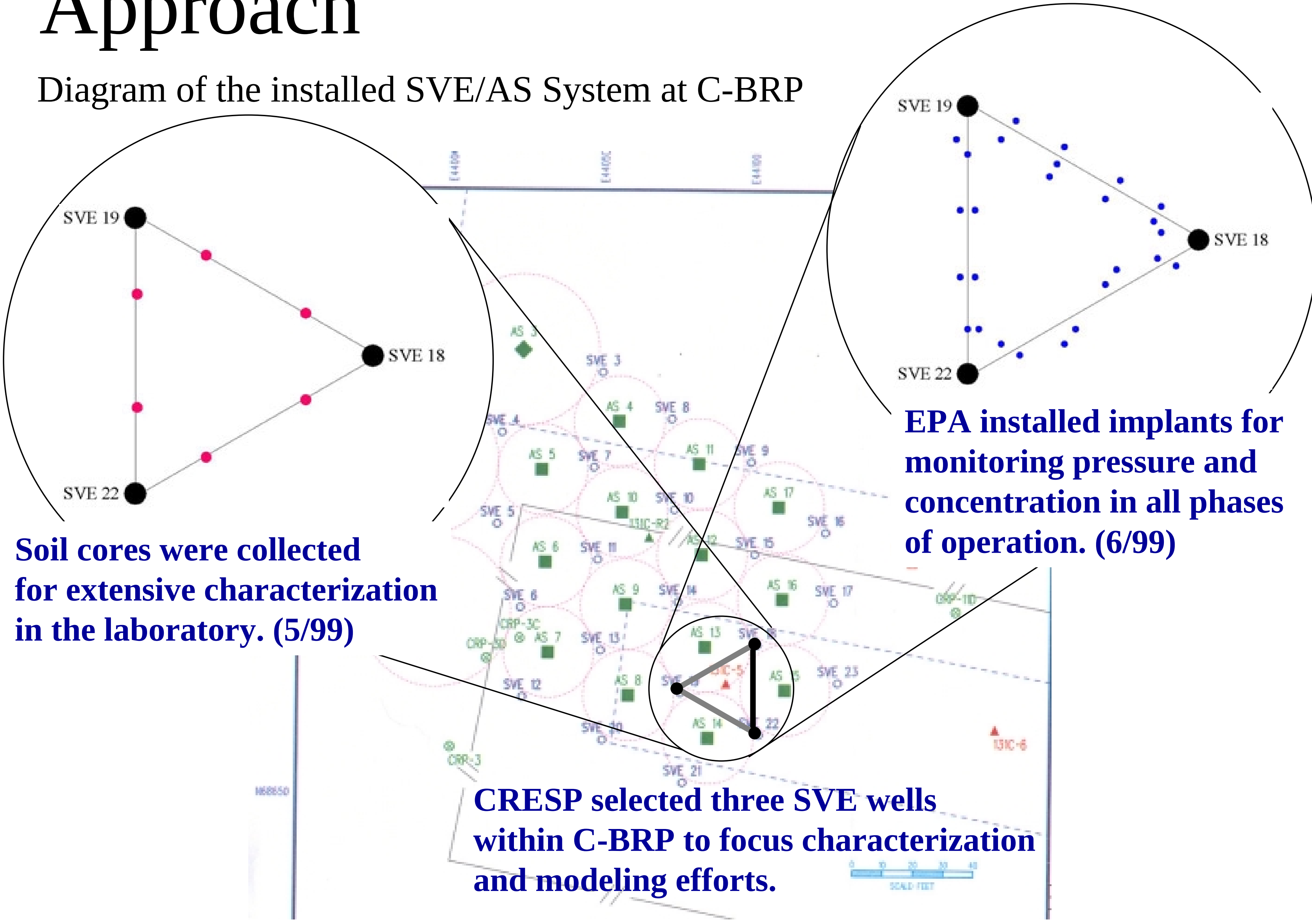
The installed SVE/AS System

CRESP Objectives for C-BRP

- Develop a contaminant mass transport model to simulate Soil Vapor Extraction (SVE) and Air Sparging (AS) unit operations.
- Incorporate stratigraphic heterogeneity and mass transfer limitations to describe “tailing” and “rebound” effects.
- Estimate the effect of continued system operation on restoration of vadose zone and groundwater quality.
- Estimate the potential benefits from intermittent system operation.
- Estimate the required duration of remediation system operation and define operational limits and achievable endpoints.
- Use the SVE/AS model to optimize the operation of the SVE/AS system at the C-Area Burning Rubble Pit (C-BRP)

Approach

Diagram of the installed SVE/AS System at C-BRP

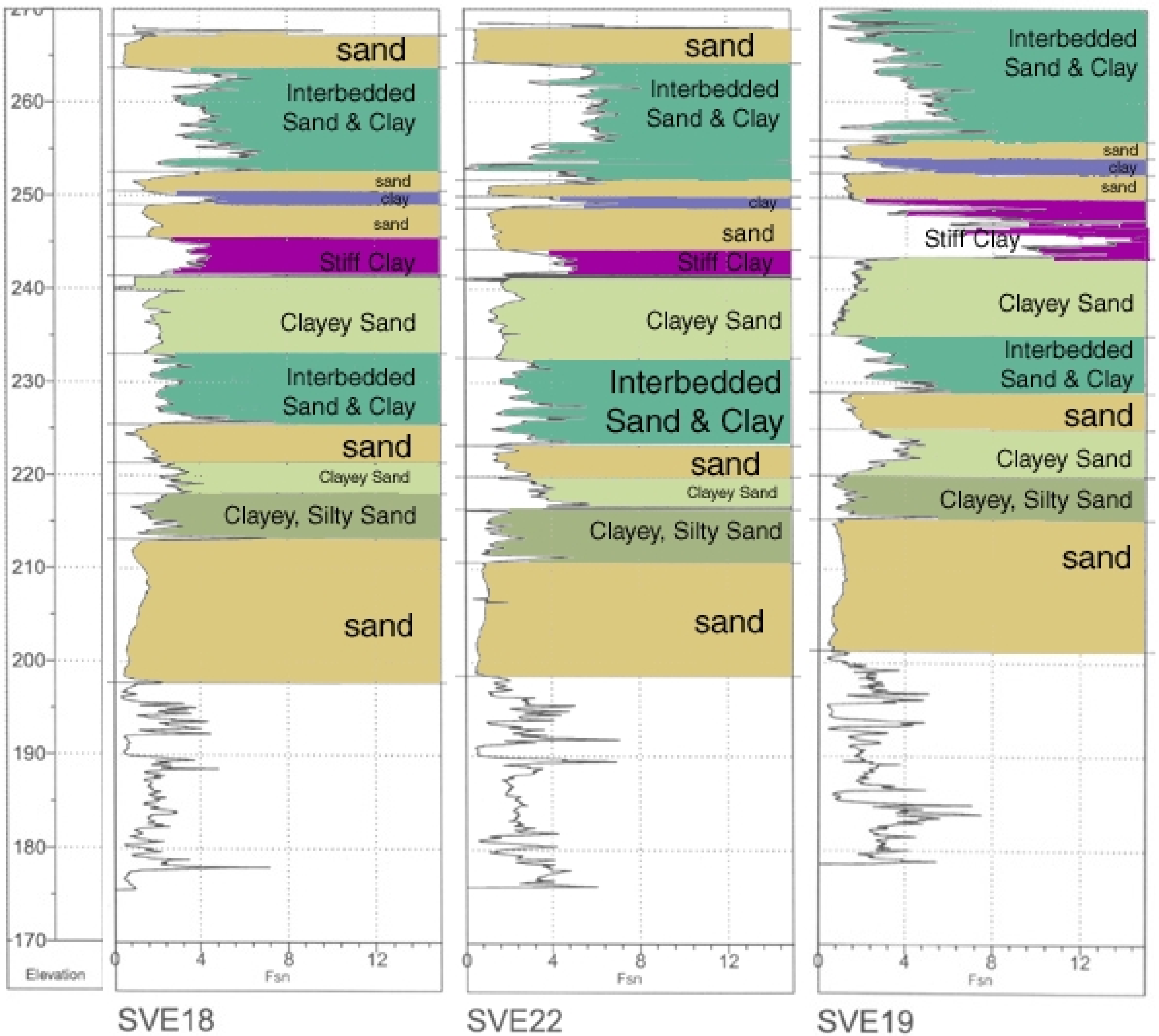


Soil cores were collected for extensive characterization in the laboratory. (5/99)

EPA installed implants for monitoring pressure and concentration in all phases of operation. (6/99)

CRESP selected three SVE wells within C-BRP to focus characterization and modeling efforts.

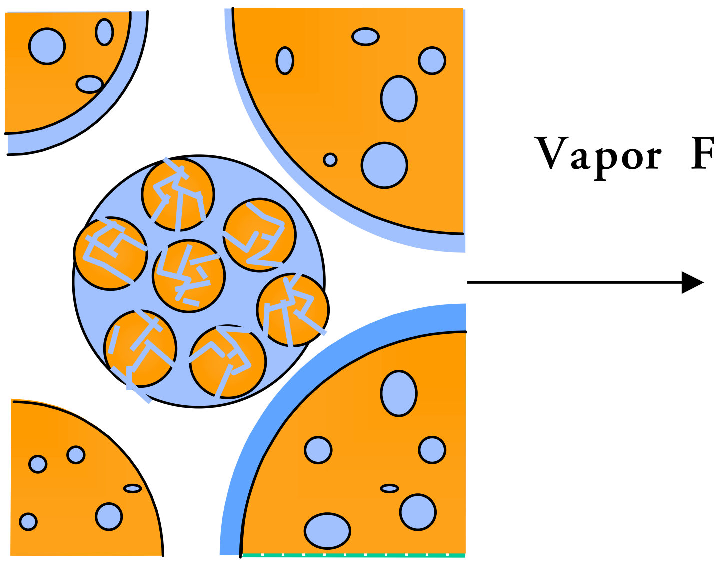
Sub-surface Stratigraphy

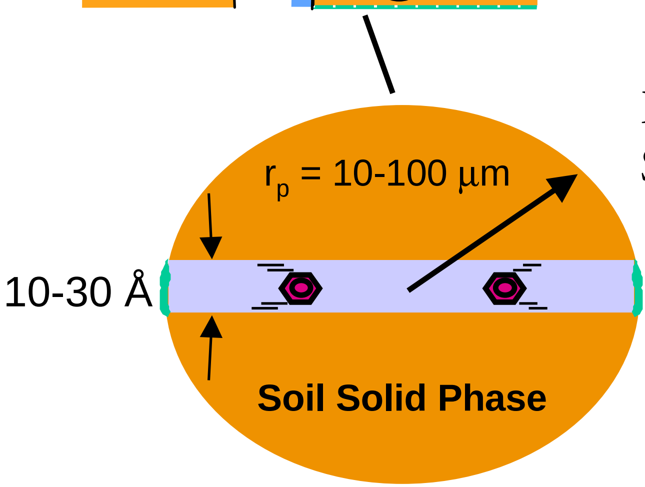


(courtesy of Greg Flach and Mary Harris (SRTC))

Modeling

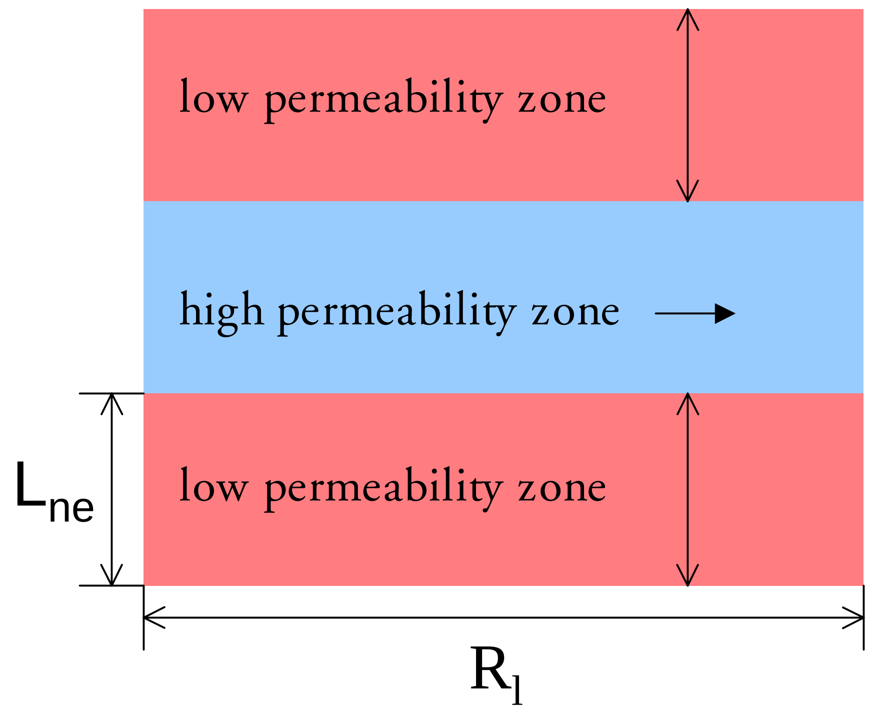
Incorporating hindered diffusion into the SVE model





Diffusion within Soil Particle (ne)

Heterogeneous Stratigraphic Layers



$$\phi_\kappa = \frac{r_{p,k}^2 \Re_{ne,k} / D_{ne,k}}{\pi L \left(R_I^2 - R_W^2\right) \Re_e / Q}$$

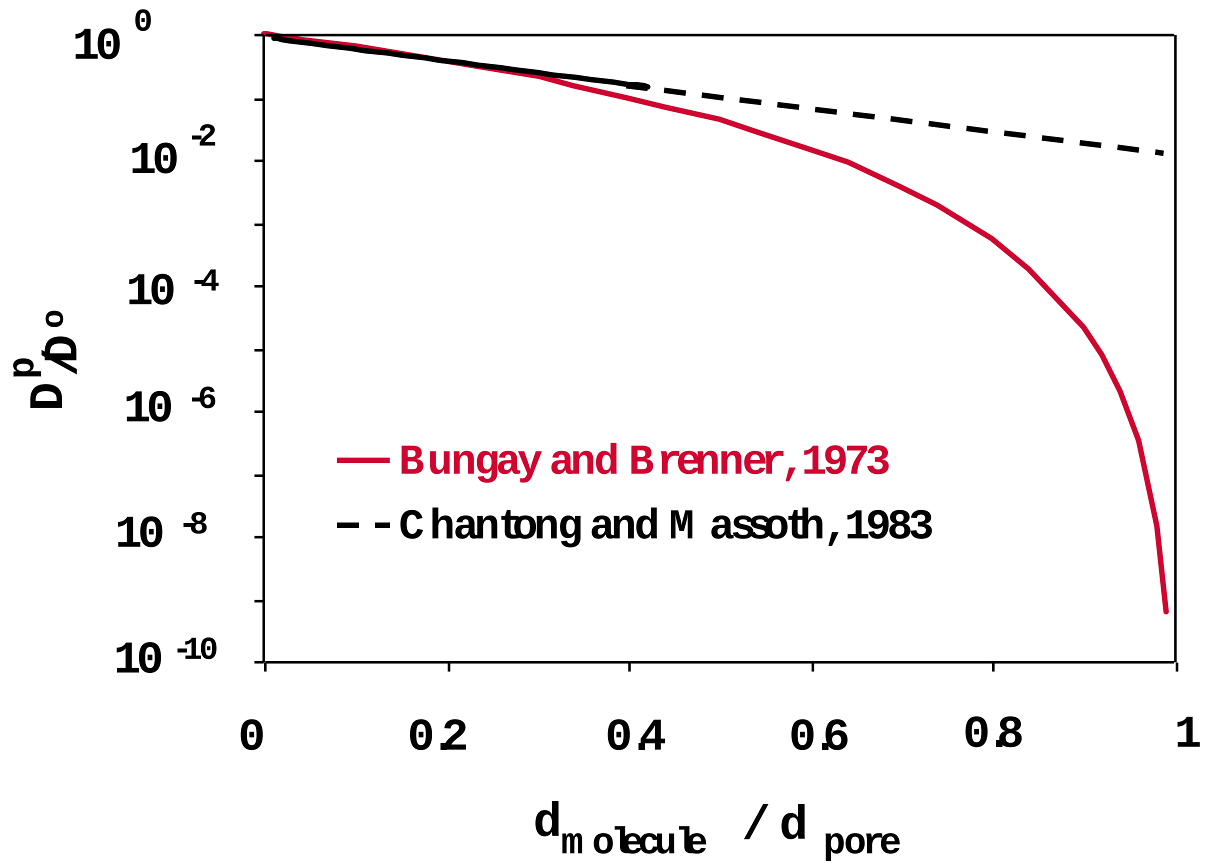
$$\phi_\kappa = \frac{L_{ne}^2 / D_{ne}}{\pi L \left(R_I^2 - R_W^2\right) \Re_e / Q}$$

Modeling

Hindered diffusion equation (Bungay and Brenner, 1973)

$$\frac{D_L^P}{D_L^o} = \frac{6\pi(1-\lambda)^2}{K_t}$$

$$K_t = \frac{9}{4}\pi^2\sqrt{2}(1-\lambda)^{-5/2}\left[1+\sum_{n=1}^{2} a_n(1-\lambda)^n\right] + \sum_{n=0}^{4} a_{n+3}\lambda^n$$



Modeling

Transformed Equilibrium Equation

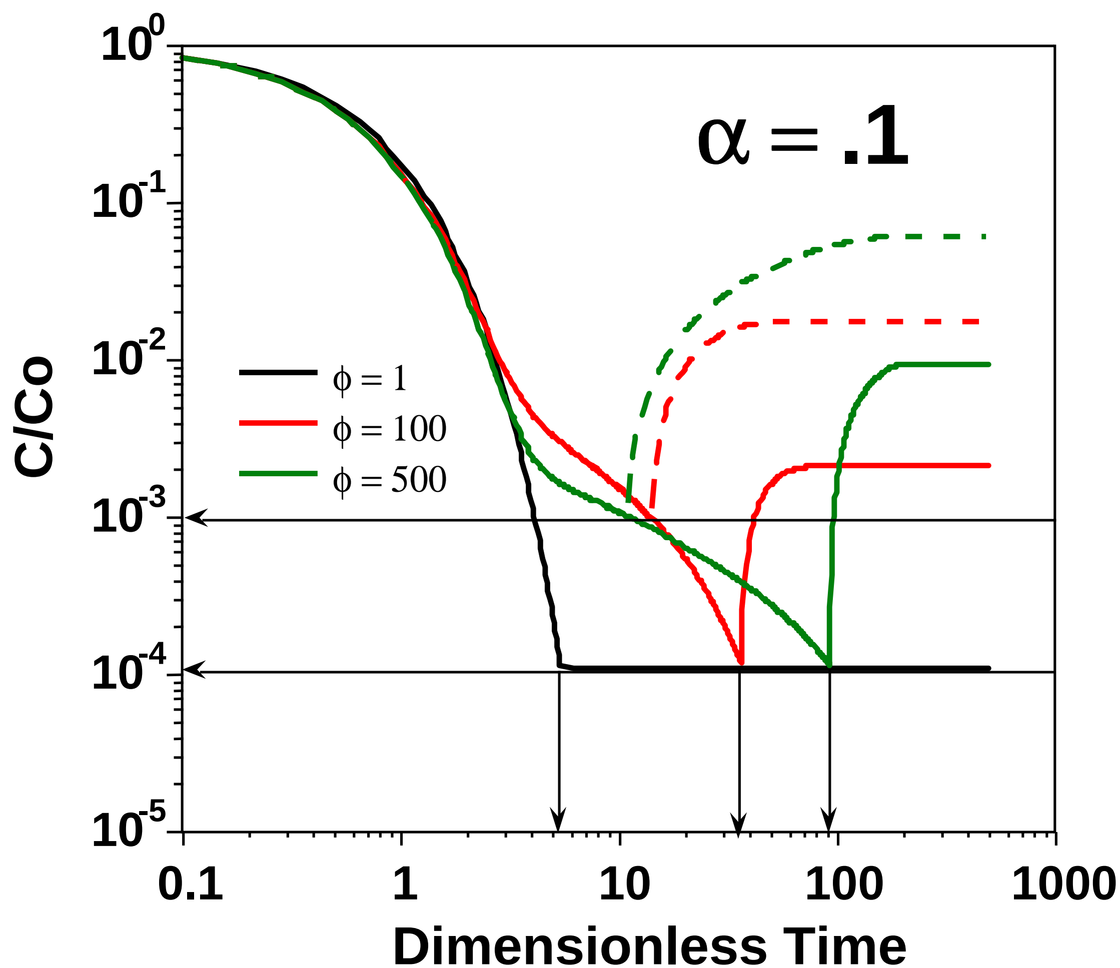
$$\frac{\partial \omega_e}{\partial T} = \frac{1}{Pe}\frac{1}{\chi}\frac{\partial}{\partial \chi}\left(\chi \frac{\partial \omega_e}{\partial \chi}\right) - \frac{1}{2\chi}\frac{\partial \omega_e}{\partial \chi} - \sum_{k=1}^{n} 3\frac{\alpha_k}{\phi_k}\frac{\partial \omega_{ne}}{\partial \xi}$$

$$Pe = \frac{Q}{\pi L D_e} \qquad \phi_k = \frac{r_{p,k}^2 \Re_{ne,k} \big/ D_{ne,k}}{\pi L\left(R_I^2 - R_W^2\right)\Re_e \big/ Q} \qquad \alpha_k = (1-\varepsilon) F_k \frac{\Re_{ne,k}}{\Re_e}$$

$$T = \frac{tQ}{\pi L\left(R_I^2 - R_W^2\right)\Re_e} \quad \chi = \frac{R}{\left(R_I^2 - R_W^2\right)^{1/2}} \quad \xi = \frac{r}{r_p} \quad \omega_{ne} = \frac{C_o - C_{ne}}{C_o} \quad \omega_e = \frac{C_o - C_e}{C_o}$$

Massry & Kosson (submitted 1999)

Choosing A Feasible Alternative Remediation End-point for Soil Vapor Extraction (R_I = 20 m, L = 6 m, Q = 10 L/sec, K_d = 5 ml/g)

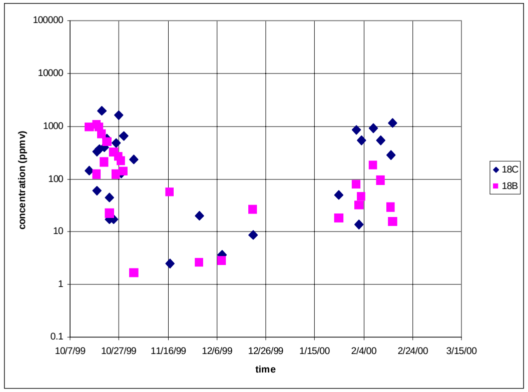


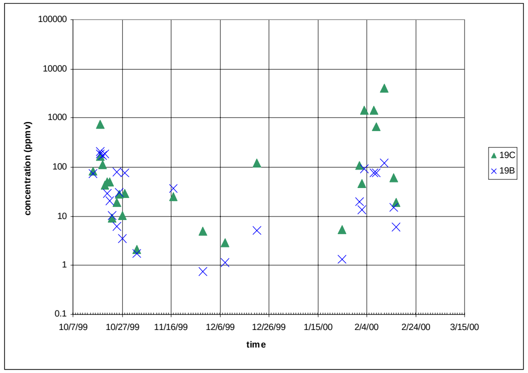
System Operation

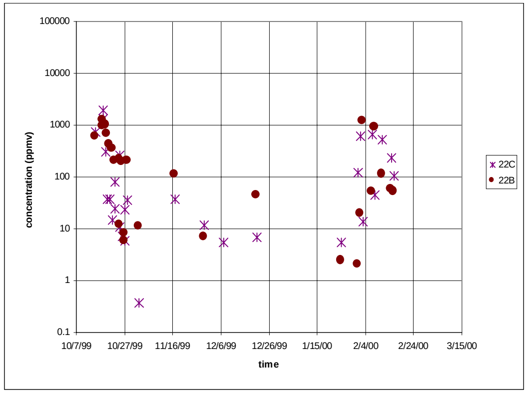
• Operation from startup (10/18/99) through rebound (2/16/00)

• For clarity, operation is shown separately for SVE 18, 19 and 22

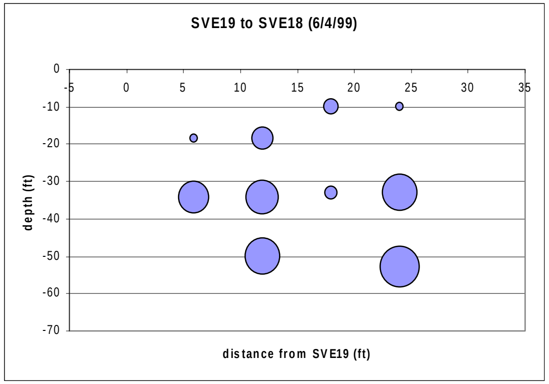
• Concentration in ppmv versus time is shown

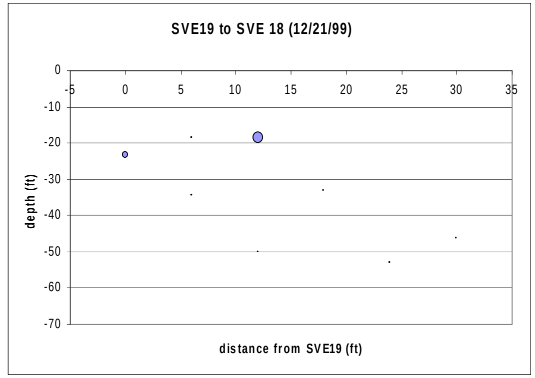


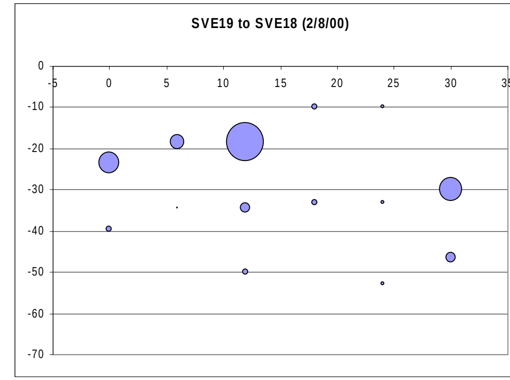


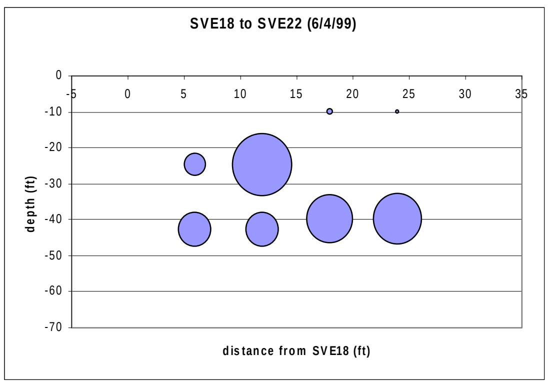


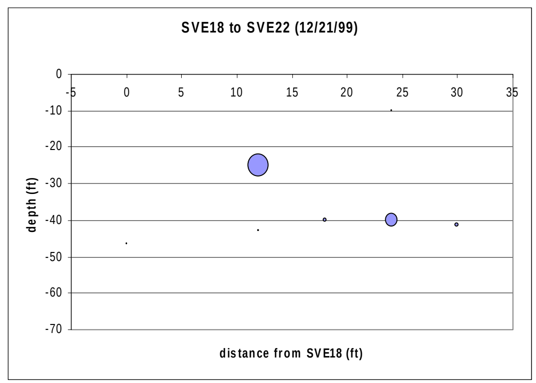
System Operation - A Two Dimensional Perspective

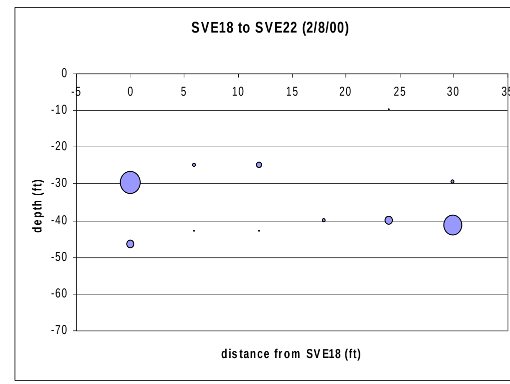


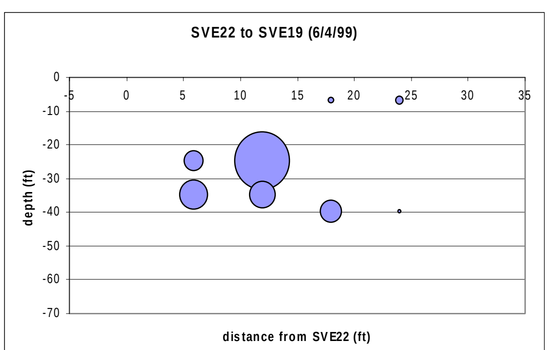


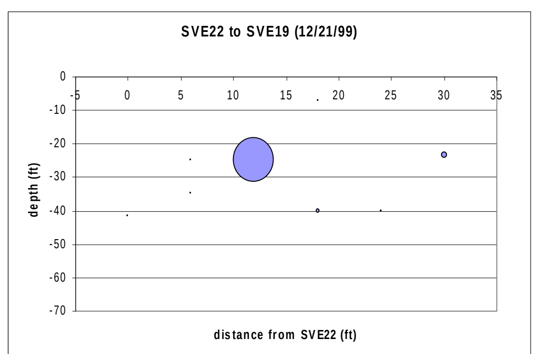


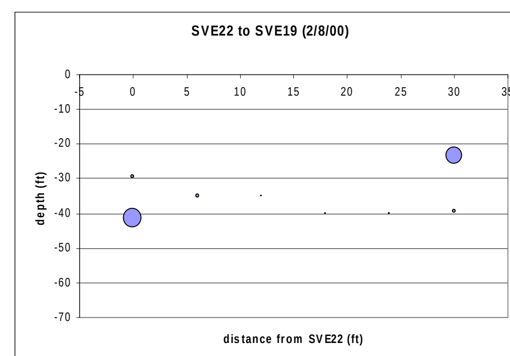












before startup | after two months of operation | after two weeks of rebound

Integrator Operable Units (IOU)

Objective: Define approach for evaluating and establishing restoration needs for large land areas

Approach:

- Provide independent input to refocus existing evaluation process
- Work closely with DOE, SCDHEC and USEPA teams to provide consistent program objectives
- Coordinate with on-going CRESP research

Expected Result:

- Process to achieve integrated evaluation, remediation, and final "sign off" on large land areas

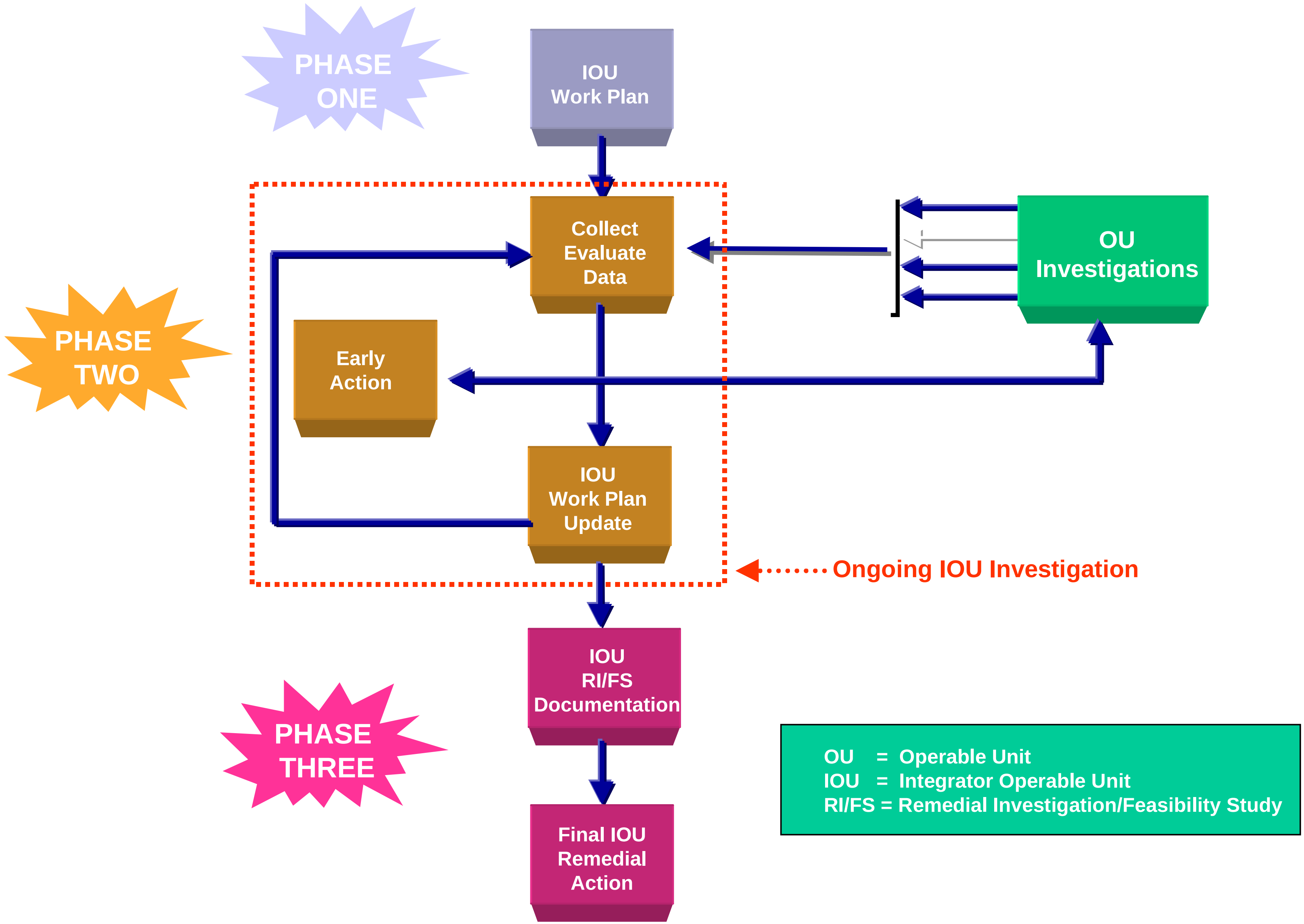
Map of SRS indicating IOU boundaries and OUs (inserted)

IOU Objectives*

- Assess risk (current and potential future) to potential human and ecological receptors from IOU contamination exposure
- Evaluation the impact of inactive and active waste units and operating facilities on IOU quality
- Determine if IOU early actions, including reprioritization of OU implementation schedules are necessary
- Complete the RI/FS process, defining the nature and extent of IOU Contamination, remedial action objectives and final remediation goals

*WSRC-RP-99-4151 rev. 0, Sept. 1999

IOU Program


PHASE ONE
IOU Work Plan
PHASE TWO
Collect Evaluate Data
OU Investigations
Early Action
IOU Work Plan Update
Ongoing IOU Investigation
PHASE THREE
IOU RI/FS Documentation
Final IOU Remedial Action
OU = Operable Unit
IOU = Integrator Operable Unit
RI/FS = Remedial Investigation/Feasibility Study

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