



Development of an Integrated Ground-Water Monitoring Strategy for Nuclear Facility Sites

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Outline

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- Technical Considerations
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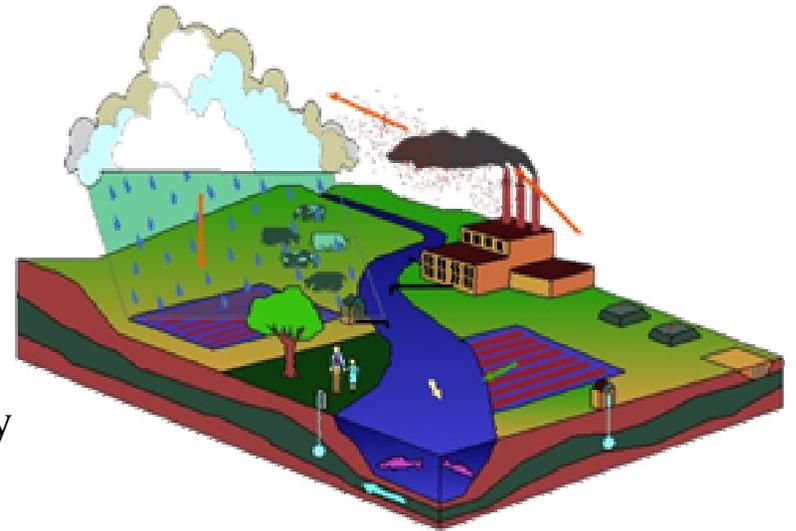
Generic Ground-Water Monitoring Needs

Ranges of site conditions to be considered:

- Sites with **no evidence of releases** (e.g., baseline, pre-operational and operational monitoring)
 - Sites with **early indication of possible failures or potential releases** (additional detection, corrective action and possible interdictive monitoring)
 - Sites with **releases and identifiable plumes** (detection, remediation, and post-remediation monitoring)
- Monitoring is site-specific and supports acceptance criteria

Radionuclide Transport in the Environment

- Modeling Chronic-Exposures:
 - Evolution of Engineered Structures
 - Advanced Source-Term Analysis
 - Reactive Transport in Ground Water
 - Exposure Pathways
 - Model, Parameter & Scenario Uncertainty
 - Model Abstraction (Simplification)
- Ground-Water Monitoring
 - Establish Background and Baseline
 - Performance Confirmation
 - Early Detection of Changes
- Spent Fuel Pool and Pipe Leakage – Detection and Corrective Action





Generic Ground-Water Monitoring Needs

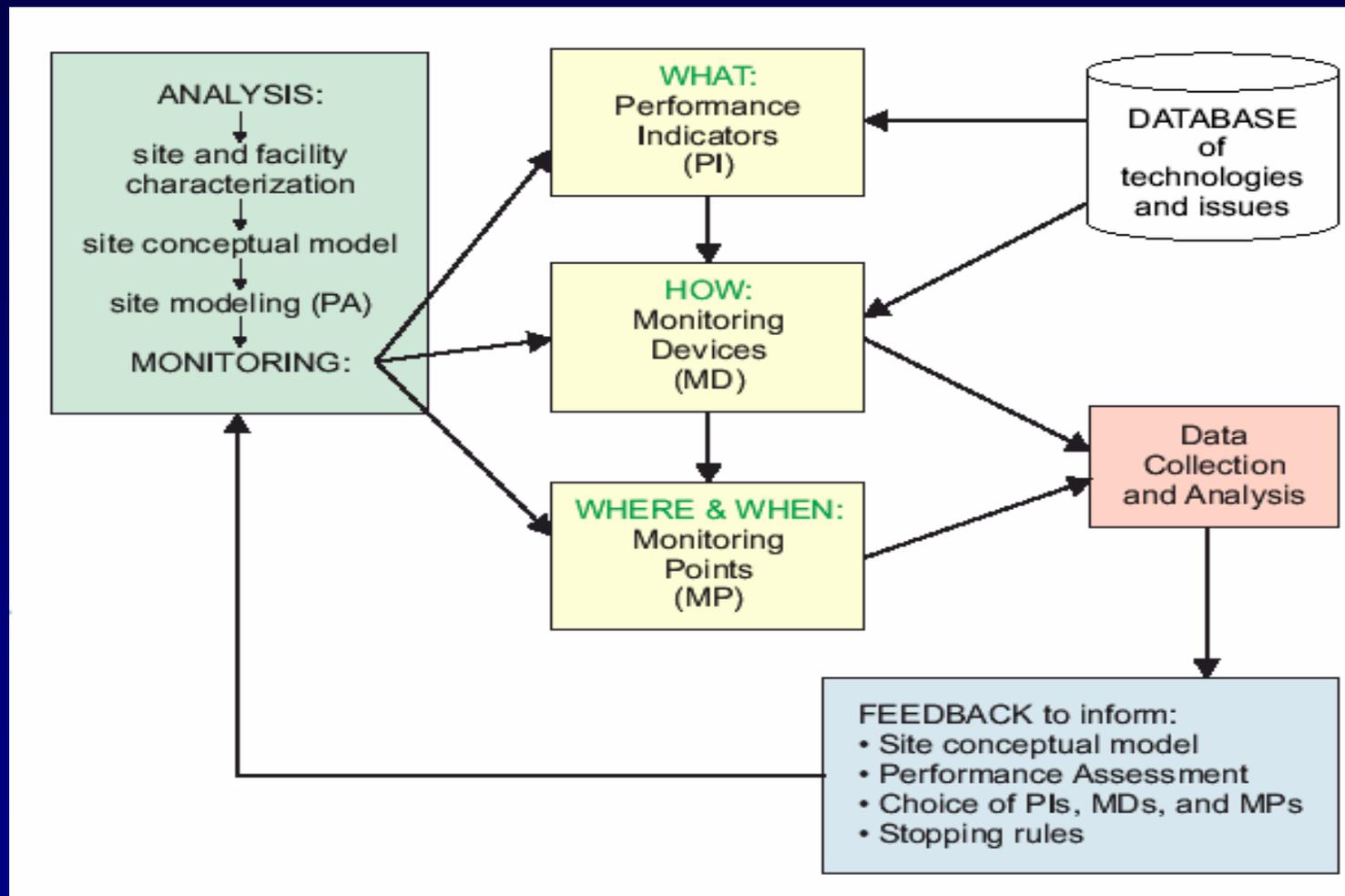
- Design monitoring systems to establish current conditions and detect changes in system behavior that may affect contaminant transport
- For sites with ground-water plumes, identify contaminant source locations, release mode, plume extent and behavior
- Develop and assess monitoring database to identify and quantify transport mechanisms (e.g., events and processes in the unsaturated and saturated zones)
- Assess preferential transport pathways (e.g., backfills, piping, heterogeneities in hydrogeology & perched-water systems) and support decisions for interdiction/remediation



Generic Ground-Water Monitoring Needs

- **Assessment should include visualization and multi-variant data analysis**
- **Identify precursors to system failures and releases [i.e., **Performance Indicators (PI's)** (e.g., H-3 concentrations)]**
- **Assess effectiveness of contaminant isolation systems (e.g., engineered barriers and surveillance pumping to capture)**
- **Develop and assess remediation approaches**
 - **Monitored natural attenuation**
 - **Pump, monitor and release**
 - **Interdict, monitor and mitigate (e.g., geochemical additives to control colloid release into a recovery well system)**
 - **In-situ bioremediation**

Strategy Overview



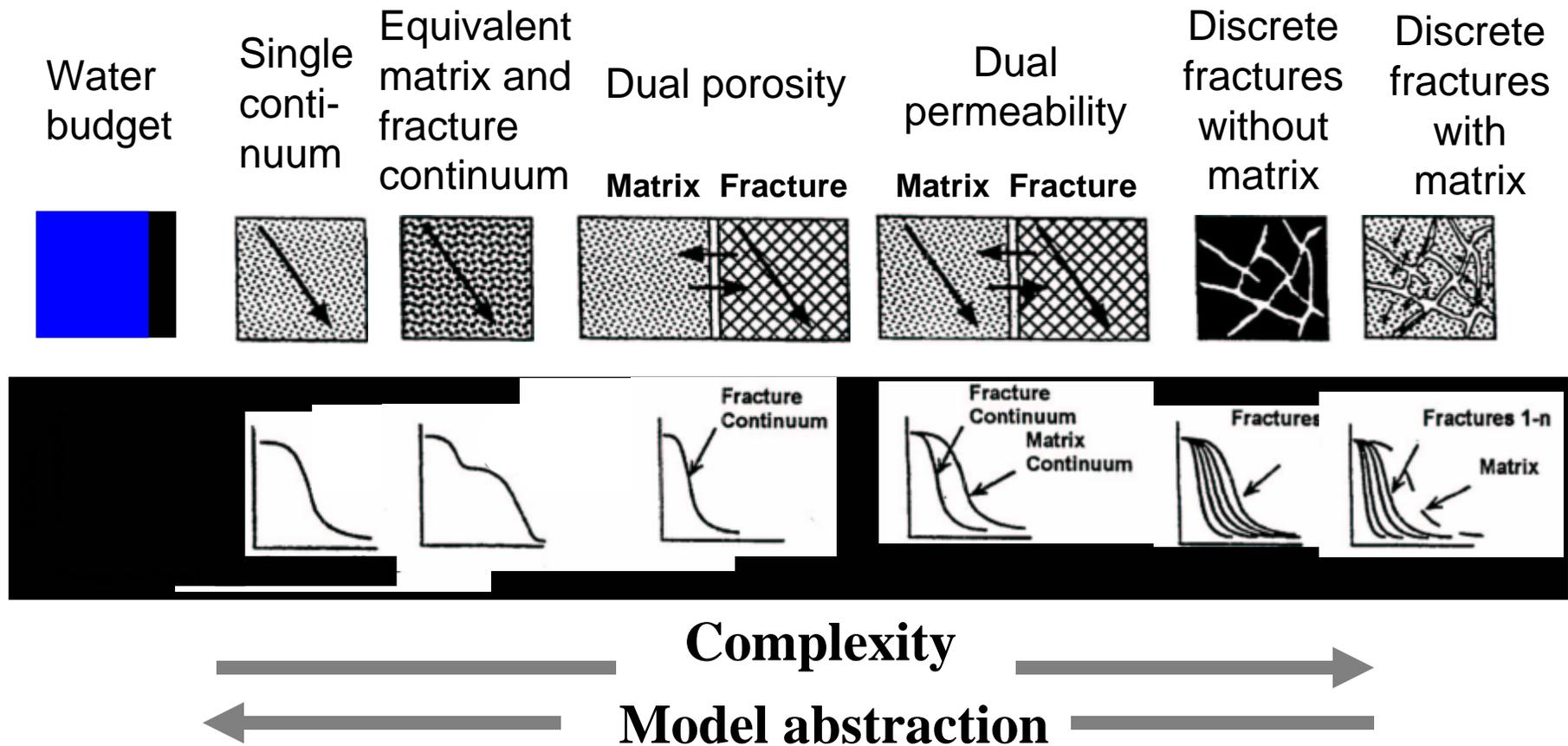


Technical Considerations

- Develop site-specific conceptual model focusing on risk-significant Features, Events and Processes (FEPs)
- Couple monitoring to conceptual model and site performance assessment (PA)
- Analyze monitoring data to confirm system performance as input to decision making (e.g., location of monitoring wells and remediation options)
- Identify alternative conceptual flow and transport models

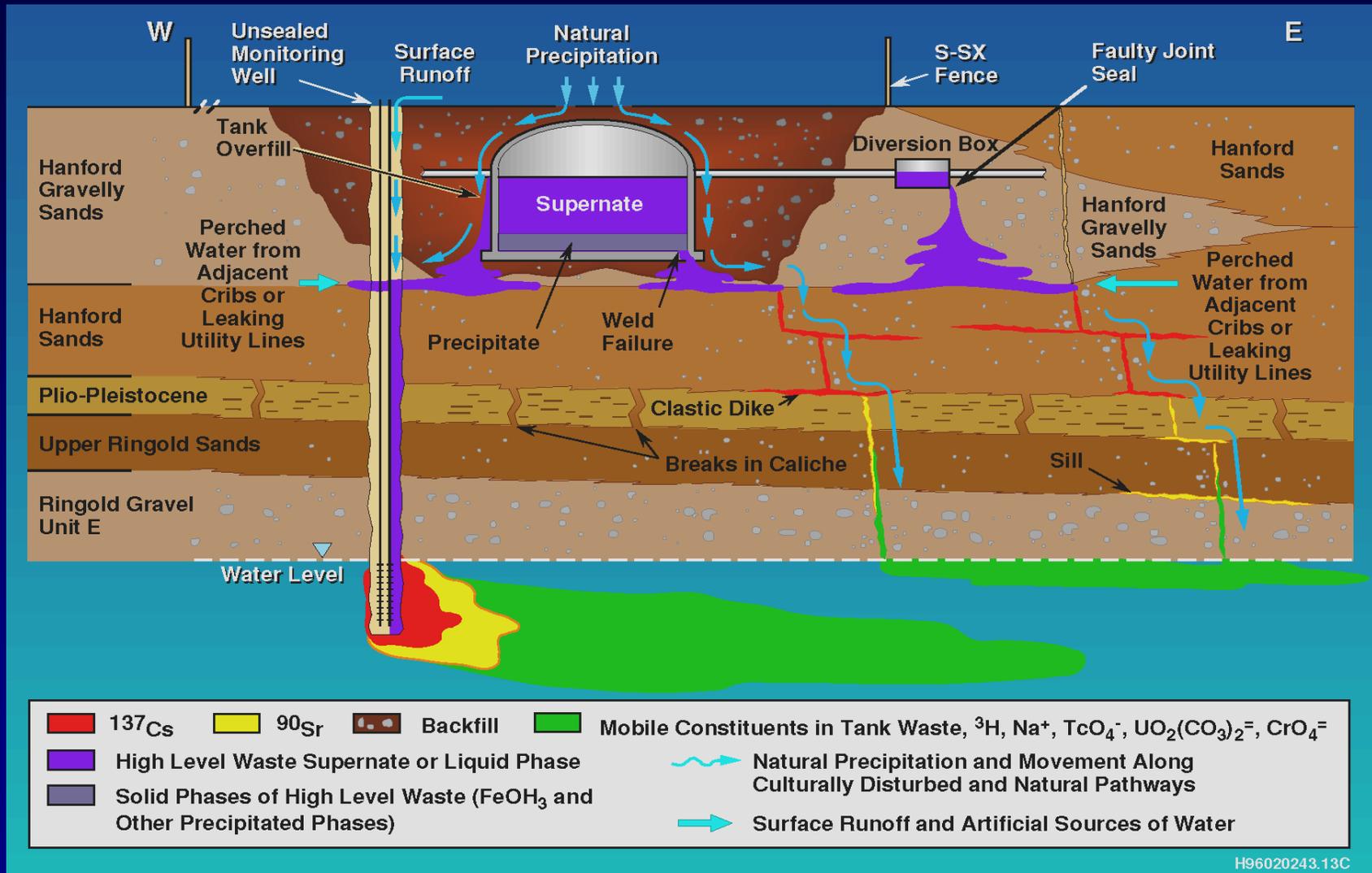
Hierarchy of Conceptual Flow Models

Models to simulate flow in soils, sediments,
unsaturated fractured rock (after Altman et al., 1996)



ARS – Yakov Pachepsky, 2006

Conceptual Model of a Complex Site



from Ward et al. (1997) after Caggiano et al. (1996)



Implementation of Strategy

- Develop and provide guidance on the technical bases useful for NRC staff evaluations of licensees' radiological environmental monitoring programs
- Develop guidance for identifying risk-significant **PI's** (e.g., Water Contents, Gradients, Flow Velocities, Contaminant Concentrations and Fluxes) to be monitored



Implementation of Strategy

- Demonstrate connection between **Performance Indicators (PI's)** and Performance Assessment (PA)
- For assessing alternative conceptual models, identify important monitoring locations and data as input to PA models (i.e, parameter estimation, model calibration and uncertainty analyses)



Attributes

IGWMS will provide practical information for:

- Understanding monitoring needs to understand potential radionuclide transport and to verify PA
- Identifying conceptual models related to transport mechanisms (e.g., source release, episodic recharge events)
- Supporting PA models of site and facility performance (e.g., identifying sources of contaminants, estimating parameter & boundary conditions & assessing uncertainties)



Attributes

IGWMS will provide practical information for:

- Assessing effectiveness of engineered systems and remediation approaches
- Communicating **PI's** thru data management, analysis and visualization to decision makers
- Addressing stakeholders' concerns related to ground-water protection



Status

- IGWMS is being tested over a range of hydrogeologic features, events and processes using site-specific monitoring datasets
- AES will present IGWMS to NRC's Advisory Committee on Nuclear Waste on September 19 – 20, 2006 at NRC Headquarters, and Geologic Society of America Meeting in Philadelphia on October 23, 2006