


## U.S. NRC Staff Experience with Conceptual Site Models from Development and Testing to Lessons Learned

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### Definition and Development of Conceptual Site Models

*Adapted from ASTM E1689.6648*  
**Conceptual Site Model** - a written or pictorial representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through environmental media to environmental receptors within the system.

*Adapted from NUREG 1757 Vol 2, Rev.1*  
Development of conceptual models is a subjective process based on interpretation of often limited site data. Key issues in developing the conceptual site model:


- (a) identifying the important site features, events, and processes that need to be included in the conceptual model;
- (b) deciding among possible competing interpretations of the site data; and
- (c) determining the level of detail needed to describe those features and processes



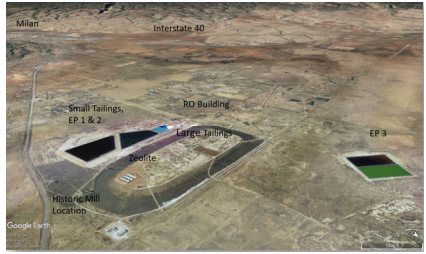
### Outline of Conceptual Site Model

- Site Information - Historical and Current Site-Related Activities
- Determination of Background Concentrations for Contaminants of Concern
- Characterization of Source Term
- Transport pathways to the accessible environment
- Potential Receptors

*Adapted from ASTM E1689.6648 Standard Guide for Developing Conceptual Site Models for Contaminated Sites*




### Site Information: Site Layout



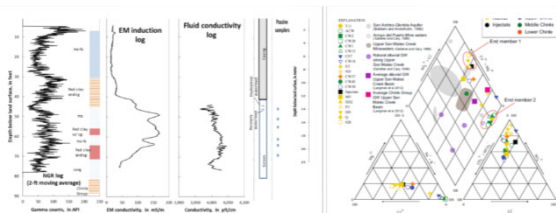
- Site history
  - R Mill operated from 1958-1990
  - R Groundwater restoration began in 1977
- Large and small tailings piles
- Network of injection and extraction wells
- Three Evaporation Ponds (EP1, EP2, EP3)
- Two collection ponds
- Reverse Osmosis (RO) and Zeolite groundwater treatment facilities
- Adjacent communities

*Adapted from Google Earth*




### Determination of Background

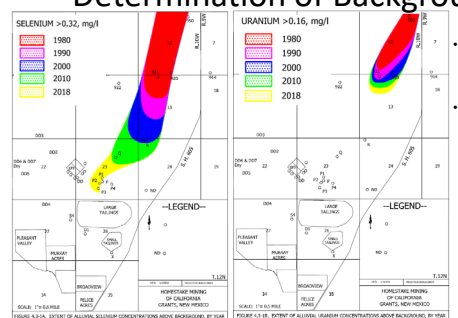
- Often limited historical data (i.e., pre-operational)
- Natural variability of hydrogeologic parameters and geochemistry
- Collection of information
- Review of background concentrations by EPA with USGS field studies & analyses
- Concurrent review by Homestake of the data
- Geophysical and geochemical analyses by USGS
- Upgradient sources



*Adapted from USGS Publications - Harte et al. (2019) and Blake et al. (2019)*




### Determination of Background

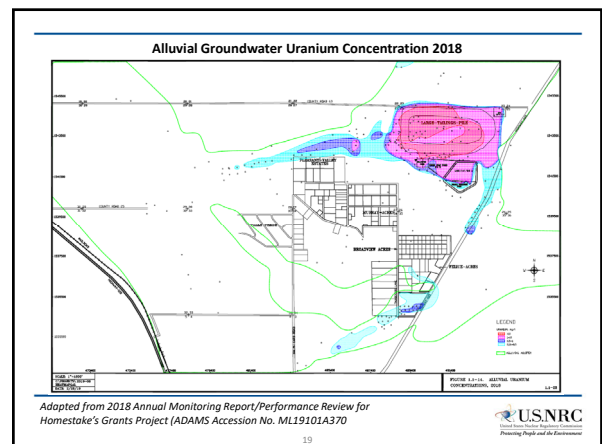
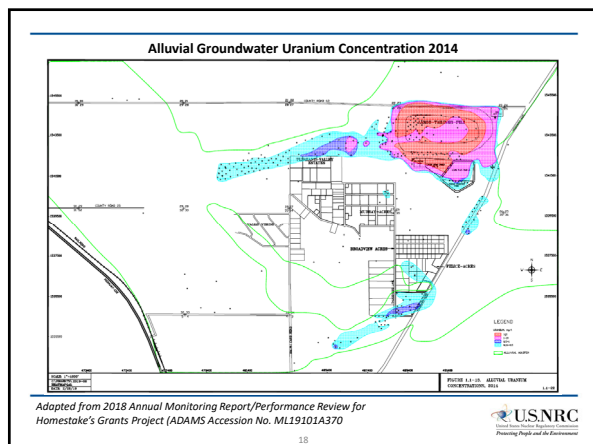
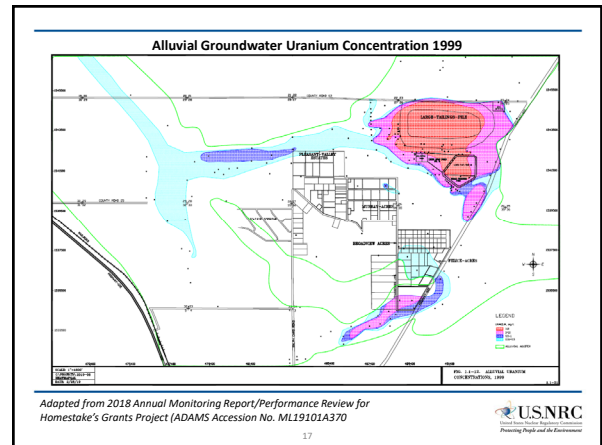
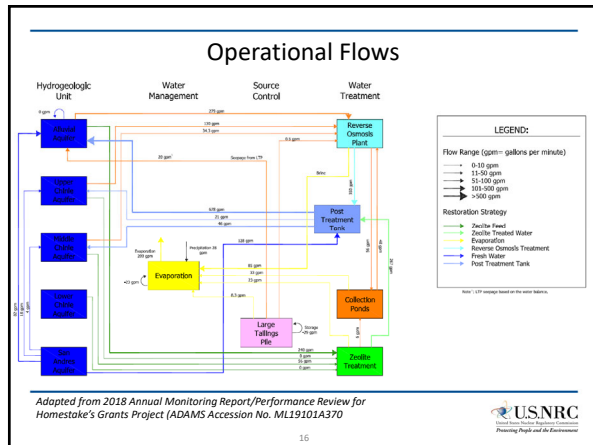
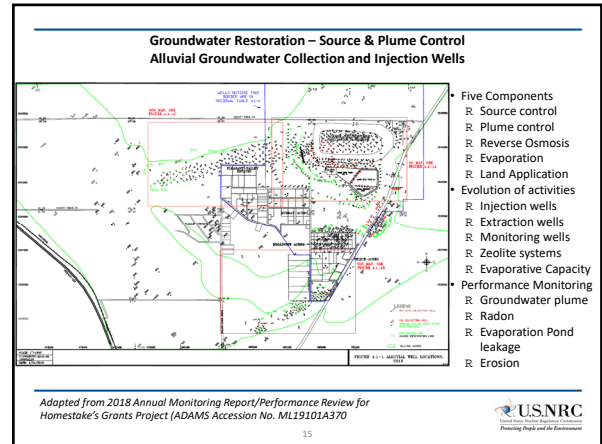
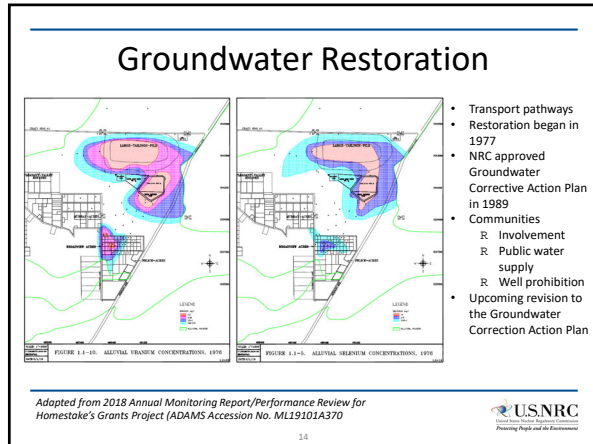


- Differentiating between natural anthropogenic sources
- Monitoring wells
  - Location
  - Quantity
  - Completion records
  - Integrity

*Adapted from 2018 Annual Monitoring Report/Performance Review for Homestake's Grants Project (ADAMS Accession No. ML19101A370)*







### Lessons Learned

- The impacts due to conceptual model uncertainty can significantly exceed those due to parameter uncertainty
- Iterative process of collecting data, identifying potential scenarios, developing conceptual and numerical models, and analyzing results
- Obtain key data to support each conceptual site model and update as needed
- Communicate uncertainties with each conceptual site model
- The use of multiple independent modelers and reviewers (i.e., a structured peer review) can help to identify conceptual model uncertainty
- All conceptual site models that are consistent with available information should be evaluated
- Interactions with local communities provide information for the modelers as well as the stakeholders and help to build confidence.