

**U.S. DEPARTMENT OF ENERGY  
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**NUCLEAR WASTE TECHNICAL REVIEW BOARD  
FULL BOARD MEETING**

**SUBJECT: INTRODUCTION TO DOE  
PERFORMANCE ASSESSMENT**

**PRESENTER: DR. JEREMY M. BOAK**

**PRESENTER'S TITLE  
AND ORGANIZATION: CHIEF, TECHNICAL ANALYSIS BRANCH  
U.S. DEPARTMENT OF ENERGY  
LAS VEGAS, NEVADA**

**PRESENTER'S  
TELEPHONE NUMBER: (702) 794-7588**

**ARLINGTON, VIRGINIA  
JANUARY 12, 1994**

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# Major TSPA-93 Objectives

- **Evaluate effects of alternative**
  - **Thermal regimes**
  - **Emplacement modes**
  - **Waste-package designs**
- **Incorporate new site information**
- **Evaluate effects of alternative performance measures**
- **Conduct sensitivity/uncertainty analyses**

# **Important Conceptual Differences Between TSPA-93 and TSPA-91**

- **Coupled thermal-hydrogeological processes for aqueous flow**
- **Enhanced radionuclide inventory, chain decay, and solubility modeling for transport**
- **Enhanced statistical and geostatistical correlations**
- **Testing of significance of fracture-matrix coupling**
- **Dependence of water-contact mode on flux and saturation history**
- **Consideration of multiple engineered barriers**

# **Cutaway of a Drift Showing Comingled Waste Package**

# **Cutaway of a Drift Showing Comingled Waste Package**

# Alternative Designs Investigated in TSPA-93

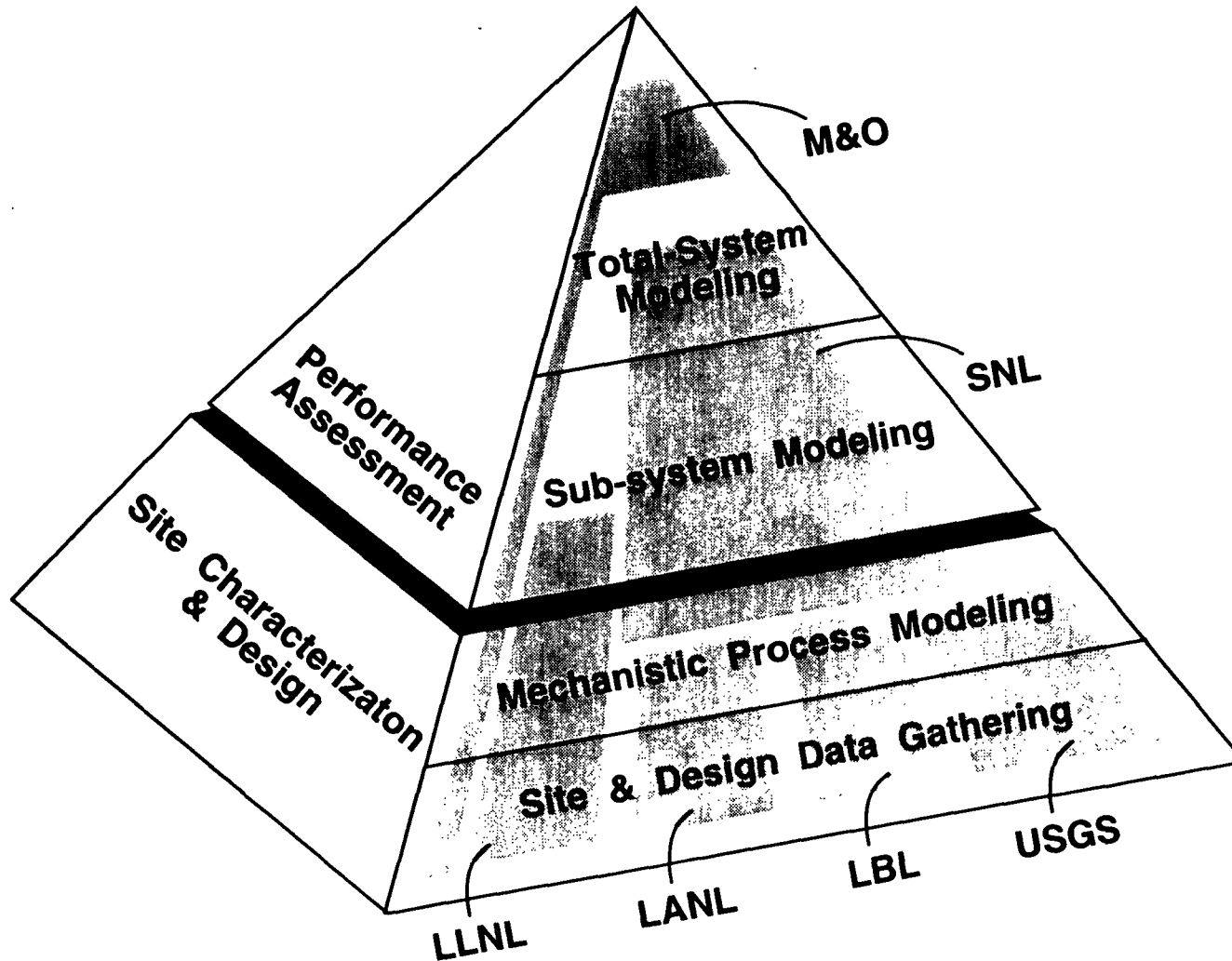
**Vertical emplacement  
SCP design**

**Alloy 825 @ 0.95cm**  
*10 cm overpack*

**In-drift emplacement - MPC**  
**Mild carbon steel @ 10, 20, or 45 cm**  
**Alloy 825 @ 0.95 cm and 3.5 cm**

Alternative Thermal Loads (kW/Ac)		
28	57	114
	✓	✓
✓	✓	✓

# Participants and Roles in Total Performance Assessment (TSPA-93)

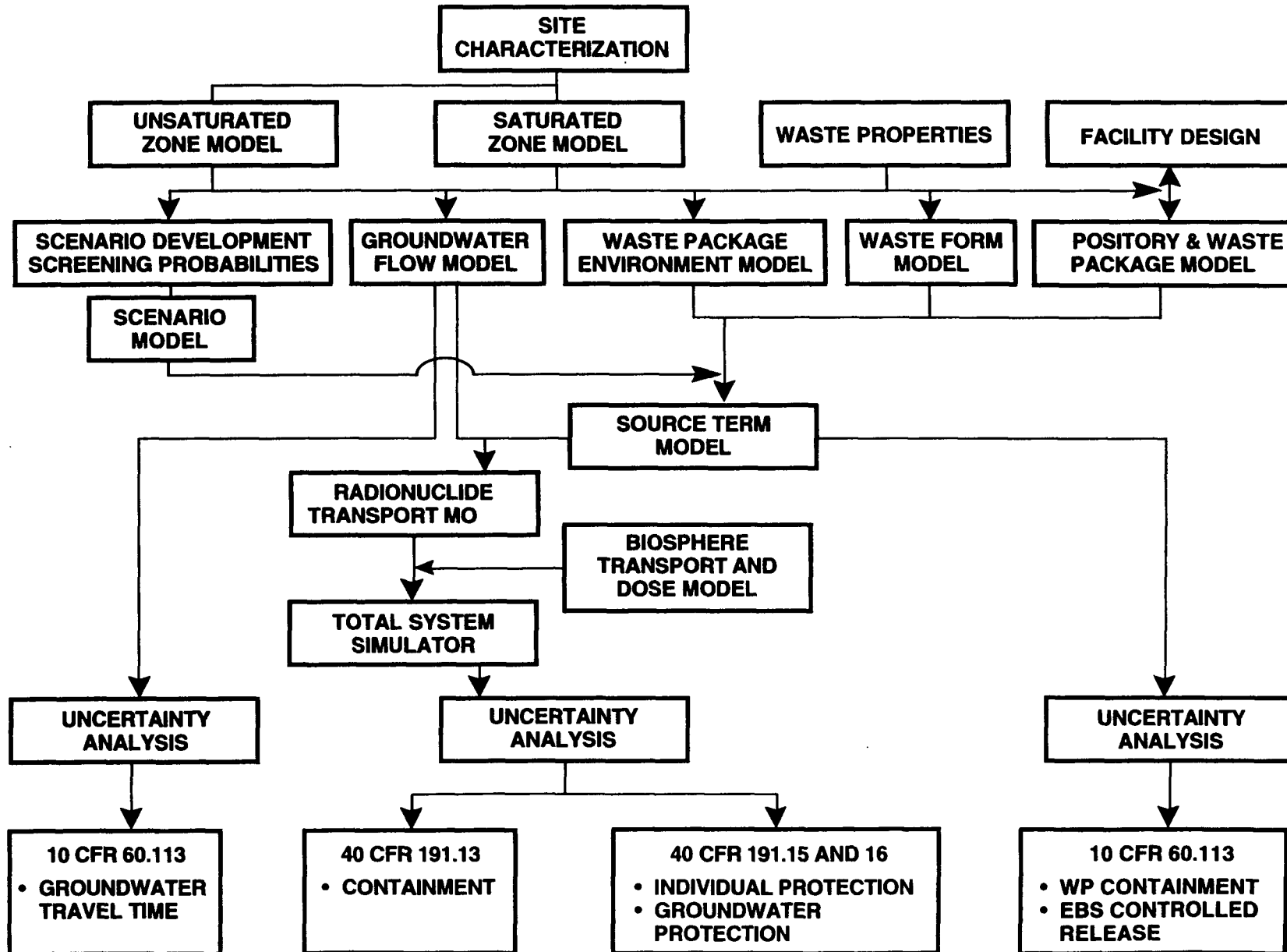




# **Objectives in Conducting Analyses for Times Greater than 10,000 Years**

- **Evaluate consequences attributable to long-lived nuclides not released over 10,000 years**
- **Provide better insight on the long-term performance of disposal alternatives**
- **Compare results to international community that considers long-term dose consequences**
- **Prepare for discussions with National Academy of Sciences Committee on the review of applicable standards for Yucca Mountain**

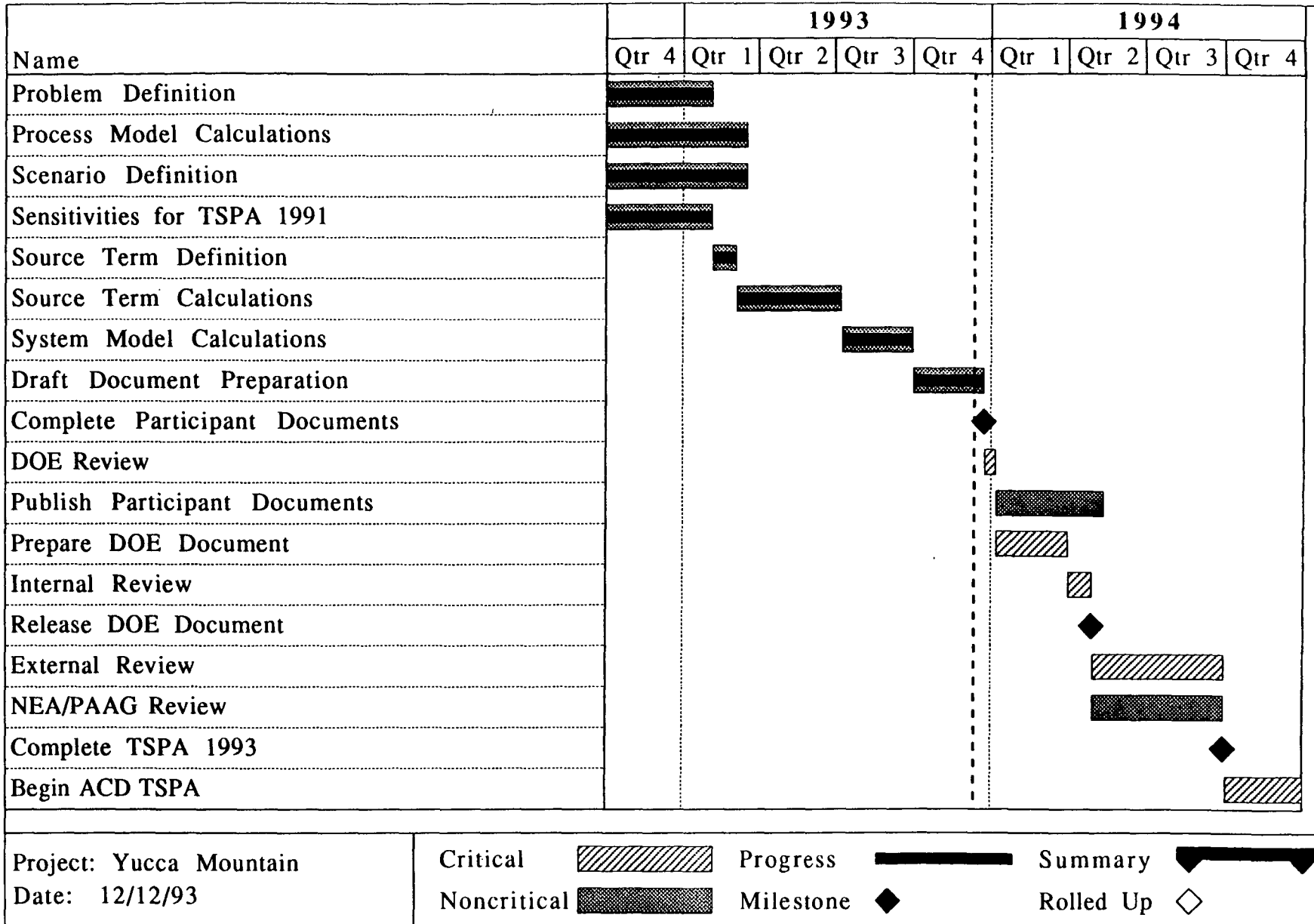
# PERFORMANCE ASSESSMENT MODEL INTEGRATION



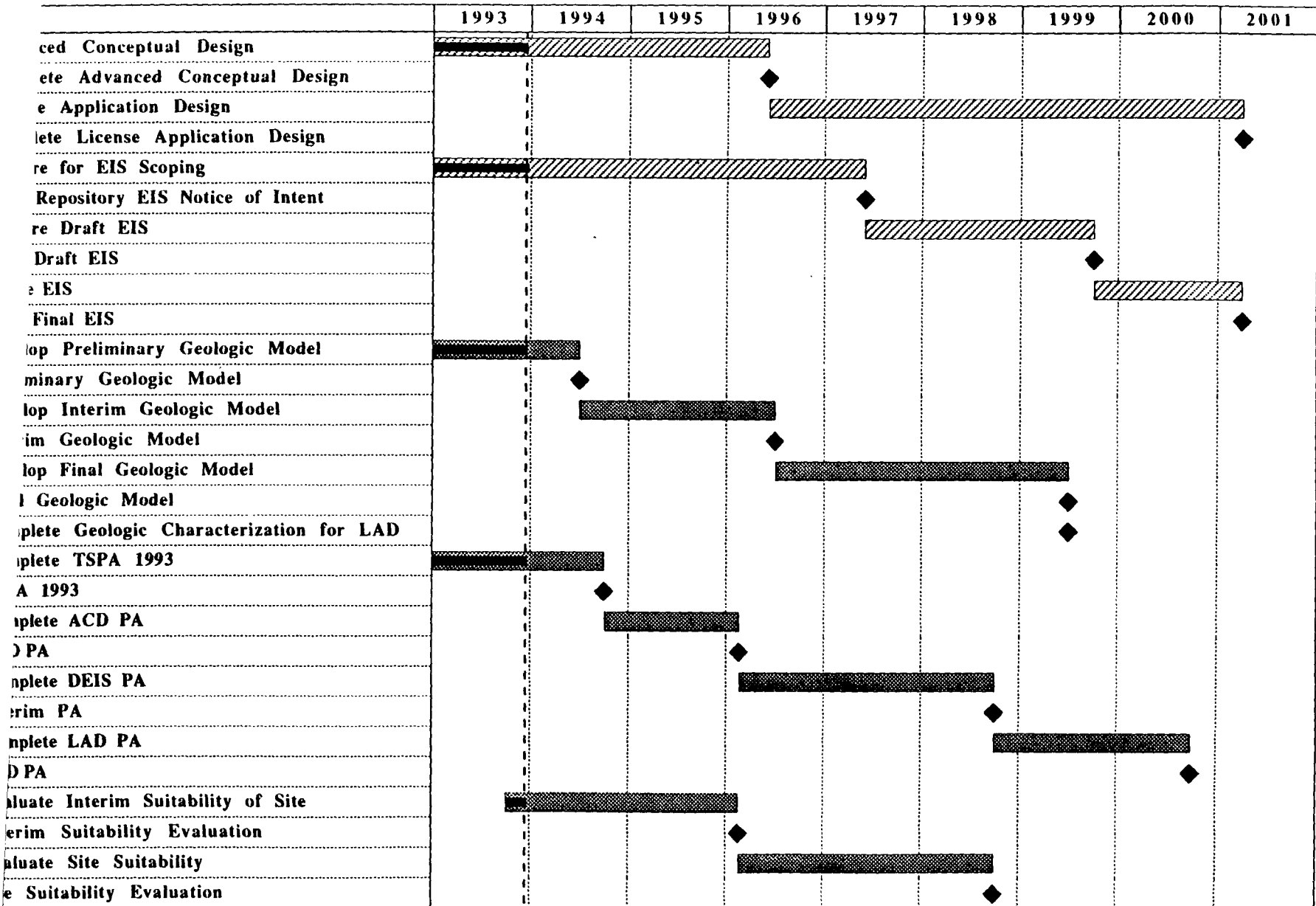
# **Future TSPAs are to Support Major Program Decisions**

- **Near-term program decisions include the following:**
  - **Site-suitability evaluation**
  - **Underground facility and engineered system design**
  - **Prioritizing and evaluating test program**
- **Longer term program decisions involve the following:**
  - **Advanced Conceptual and License Application Designs**
  - **Site Recommendation Report**
  - **Environmental Impact Statement**
  - **Safety Analysis Report/License Application**







# TSPA 1993 Schedule










# TSPA 1993 Schedule


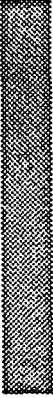




Project: Yucca Mountain  
 Date: 12/12/93





Critical  Progress  Summary   
 Noncritical  Milestone  Rolled Up 

WBS	SCP Number	Title	Budget	PA Data?
<b>1.2.3 SITE INVESTIGATIONS</b>			<b>58965</b>	
<b>1.2.3.1 Coordination and Planning</b>			<b>7844</b>	
<b>1.2.3.2 Geology</b>			<b>13361</b>	
1.2.3.2.1.1.1	8.3.1.3.2.1	Mineralogy, Petrology & Rock Chemistry of Transport Pathways	725	
1.2.3.2.1.1.2	8.3.1.3.2.2	Mineralogic & Geochemical Alteration	741	
1.2.3.2.1.2.2	8.3.1.3.3.2	Kinetics and Thermodynamics of Mineral Evolution	186	
1.2.3.2.2.1.1	8.3.1.4.2.1	Vertical and Lateral Distribution of Stratigraphic Units in Site Area	1250	
1.2.3.2.2.1.2	8.3.1.4.2.2	Structural Features Within the Site Area	1856	
1.2.3.2.2.2.1	8.3.1.4.3.1	Systematic Acquisition of Site Specific Subsurface Information	455	
1.2.3.2.2.2.2	8.3.1.4.3.2	3-D Rock Characteristics Models	302	
1.2.3.2.5.1.1	8.3.1.8.1.1	Probability of Volcanic Eruption	167	
1.2.3.2.5.1.2	8.3.1.8.1.2	Effects of a Volcanic Eruption Penetrating the Repository	365	
1.2.3.2.5.3.1	8.3.1.8.3.1	Effects of Tectonic Processes & Events on Average Percolation Flux Rates	80	
1.2.3.2.5.5.1	8.3.1.8.5.1	Characteristics of Volcanic Features	533	
1.2.3.2.5.5.2	8.3.1.8.5.2	Characteristics of Igneous Intrusive Features	140	
1.2.3.2.6.2.1	8.3.1.14.2.1	Surface Facilities Exploration Program	220	
1.2.3.2.6.2.2	8.3.1.14.2.2	Surface Facilities Lab Tests & Material Properties Measurements	71	
1.2.3.2.6.2.3	8.3.1.14.2.3	Surface Facilities Field Tests & Characteristics Measurements	425	
1.2.3.2.7.1.1	8.3.1.15.1.1	Laboratory Thermal Properties	880	
1.2.3.2.7.1.2	8.3.1.15.1.2	Laboratory Thermal Expansion Testing	332	
1.2.3.2.7.1.3	8.3.1.15.1.3	Laboratory Determination of Mechanical Properties of Intact Rock	470	
1.2.3.2.7.1.4	8.3.1.15.1.4	Laboratories Determination of the Mechanical Properties of Fractures	600	
1.2.3.2.7.2.2	8.3.1.15.2.2	Site Ambient Thermal Conditions	80	
1.2.3.2.8.3.1	8.3.1.17.3.1	Relevant Earthquake Sources	200	
1.2.3.2.8.3.3	8.3.1.17.3.3	Ground Motion from Regional Earthquakes & Underground Nuclear Explosions	145	
1.2.3.2.8.3.4	8.3.1.17.3.4	Effect of Local Site Geology on Surface & Subsurface Motions	65	
1.2.3.2.8.4.1	8.3.1.17.4.1	Historical and Current Seismicity	1693	
1.2.3.2.8.4.2	8.3.1.17.4.2	Location & Recency of Faulting Near Prospective Surface Facilities	110	


FY1994 Site Budget

WBS	SCP Number	Title	Budget	PA Data?
<b>1.2.3.2 Geology (continued)</b>			<b>13361</b>	
1.2.3.2.8.4.3	8.3.1.17.4.3	Quaternary Faulting within 100 km of Yucca Mountain	350	
1.2.3.2.8.4.4	8.3.1.17.4.4	Quaternary Faulting in NE- Trending Fault Zones	120	
1.2.3.2.8.4.5	8.3.1.17.4.5	Detachment Faults	195	
1.2.3.2.8.4.6	8.3.1.17.4.6	Quaternary Faulting within the Site Area	390	
1.2.3.2.8.4.10	8.3.1.17.4.10	Geodetic Leveling	45	
1.2.3.2.8.4.12	8.3.1.17.4.12	Tectonic Models & Synthesis	170	
<b>1.2.3.3 Hydrology</b>			<b>12569</b>	
1.2.3.3.1.1.1	8.3.1.2.1.1	Precipitation & Meteorology Monitoring for Regional Hydrology	200	
1.2.3.3.1.1.2	8.3.1.2.1.2	Runoff & Streamflow	400	
1.2.3.3.1.1.3	8.3.1.2.1.3	Regional Ground-water Flow System	150	
1.2.3.3.1.1.4	8.3.1.2.1.4	Regional Hydrology System Synthesis & Modeling	100	
1.2.3.3.1.2.1	8.3.1.2.2.1	Unsaturated Zone Infiltration	675	
1.2.3.3.1.2.2	8.3.1.2.2.2	Water Movement Tracer Tests	445	
1.2.3.3.1.2.3	8.3.1.2.2.3	Percolation in the Unsaturated Zone - Surface Based Study	3890	
1.2.3.3.1.2.4	8.3.1.2.2.4	Percolation in the Unsaturated Zone - ESF Study	3920	
1.2.3.3.1.2.6	8.3.1.2.2.6	Gaseous-Phase Movement in the Unsaturated Zone	350	
1.2.3.3.1.2.7	8.3.1.2.2.7	Unsaturated Zone Hydrochemistry	425	
1.2.3.3.1.2.9	8.3.1.2.2.9	Site Unsaturated Zone Modeling & Synthesis	100	
1.2.3.3.1.3.1	8.3.1.2.3.1	Site Saturated Zone Ground-water flow system	1369	
1.2.3.3.1.3.2	8.3.1.2.3.2	Saturated Zone Hydrochemistry	120	
1.2.3.3.1.3.3	8.3.1.2.3.3	Saturated Zone Hydrologic System Synthesis & Modeling	425	
<b>1.2.3.4 Geochemistry</b>			<b>4683</b>	
1.2.3.4.1.1	8.3.1.3.1	Groundwater Chemistry Model	186	
1.2.3.4.1.2.1	8.3.1.3.4.1	Batch Sorption Studies	771	
1.2.3.4.1.2.3	8.3.1.3.4.3	Sorption Models	162	
1.2.3.4.1.3.1	8.3.1.3.5.1	Dissolved Species Concentration Limits	1068	
1.2.3.4.1.3.2	8.3.1.3.5.2	Colloid Behavior	70	

FY1994 Supplemental Budget

WBS	SCP Number	Title	Budget	PA Data?
<b>1.2.3.4 Geochemistry (continued)</b>			<b>4683</b>	
1.2.3.4.1.4.1	8.3.1.3.6.1	Dynamic Transport Column Experiments	824	
1.2.3.4.1.4.2	8.3.1.3.6.2	Diffusion	120	
1.2.3.4.1.5.1	8.3.1.3.7.1	Retardation Sensitivity Analysis	601	
1.2.3.4.1.5.2	8.3.1.3.7.2	Demonstration of Application Laboratory Data	500	
1.2.3.4.2		Geochemical Modelling	381	
<b>1.2.3.5 Drilling</b>			<b>14385</b>	
1.2.3.5.1		Sample Management Facility	3525	
1.2.3.5.2.1	8.3.1	Common-to-Drilling Support	3730	
1.2.3.5.2.2	8.3.1	Engineering, Design and Drilling Support	3315	
1.2.3.5.2.3	8.3.1.2.2.3.2	Integrated Data Acquisition System (IDAS)	100	
1.2.3.5.2.4		Title III Engineering For SBT	15	
1.2.3.5.3.5	8.3.1.2.2.3.2	Unsaturated Zone, Vertical and Seismic Profiles & Prototype Drillholes & Tests	750	
1.2.3.5.3.11	8.3.1.2.3.1.2	Multiple Well Interference Tests at C-Hole Complex	500	
1.2.3.5.3.17	8.3.1.4.3.1	Geostatistical Drillholes	1500	
1.2.3.5.3.20	8.3.1.14.2.1	Surface Facilities Drillholes	700	
1.2.3.5.3.22	8.3.1.17.4.8	In Situ Stress Drillhole & Tests & Quaternary Fault Trenches	100	
1.2.3.5.3.23		Access and Pad Construction	150	
<b>1.2.3.6 Climatology and Meteorology</b>			<b>1102</b>	
1.2.3.6.2.1.2	8.3.1.5.1.2	Paleoclimate Study of Lake, Playa, & Marsh Deposits	244	
1.2.3.6.2.1.3	8.3.1.5.1.3	Climatic Implications of Terrestrial Paleoecology	58	
1.2.3.6.2.1.6	8.3.1.5.1.6	Future Regional Climate and Environments	600	
1.2.3.6.2.2.1	8.3.1.5.2.1	Quaternary Regional Hydrology	200	
<b>1.2.3.7 Resource Potential</b>			<b>60</b>	
1.2.3.7.2.1	8.3.1.9.2.1	Natural Resource Assessment	60	



WBS	SCP Number	Title	Budget	PA Data?
<b>1.2.3.9 Special Studies</b>			<b>3536</b>	
1.2.3.9.3		Test Interference Evaluations	500	
1.2.3.9.4		Tracers, Fluids and Materials	400	
1.2.3.9.5		3-D Site Model	1080	
1.2.3.9.6		Field Test Coordinator Support	350	
1.2.3.9.7		ESF Field Test Coordinator	1206	
<b>1.2.3.10 Altered Zone Characterization</b>			<b>250</b>	
1.2.3.10.1		Characterization Techniques for the Altered Zone	125	
1.2.3.10.2		Characterization of Thermal Effects on the Altered Zone	125	
<b>1.2.3.11 Geophysics</b>			<b>1175</b>	
1.2.3.11.1		Borehole Geophysical Logging	580	
1.2.3.11.2		Surface Geophysics	295	
1.2.3.11.3		ESF Geophysics	300	