

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

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

**SUBJECT: EVOLUTION OF PERFORMANCE  
ASSESSMENT IN THE YUCCA  
MOUNTAIN PROJECT**

**PRESENTER: DR. SCOTT SINNOCK**

**PRESENTER'S TITLE  
AND ORGANIZATION: SENIOR STAFF  
M&O/TRW  
LAS VEGAS, NEVADA**

**PRESENTER'S  
TELEPHONE NUMBER: (702) 794-7200**

**ARLINGTON, VIRGINIA  
JANUARY 12, 1994**

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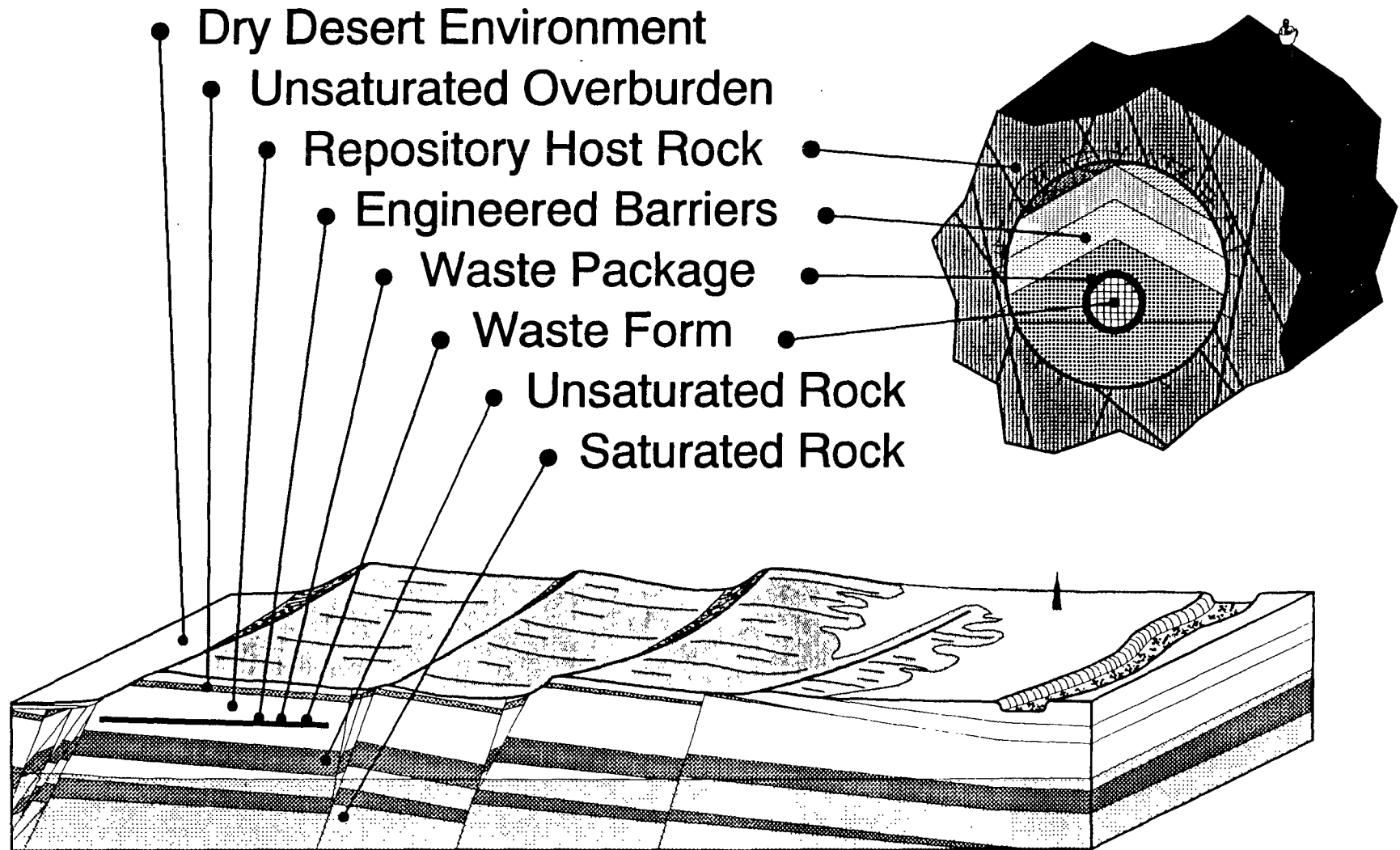
# Outline

- **Context of Yucca Mountain assessments**
- **History of performance calculations**
- **Thoughts about closure criteria**

# Context of Performance Assessment

- **Multiple-barrier repository system**
- **Managed information flow through**
  - **System engineering**
  - **SCP performance allocation**
  - **Interactive performance assessments**
- **Periodic suitability evaluations**

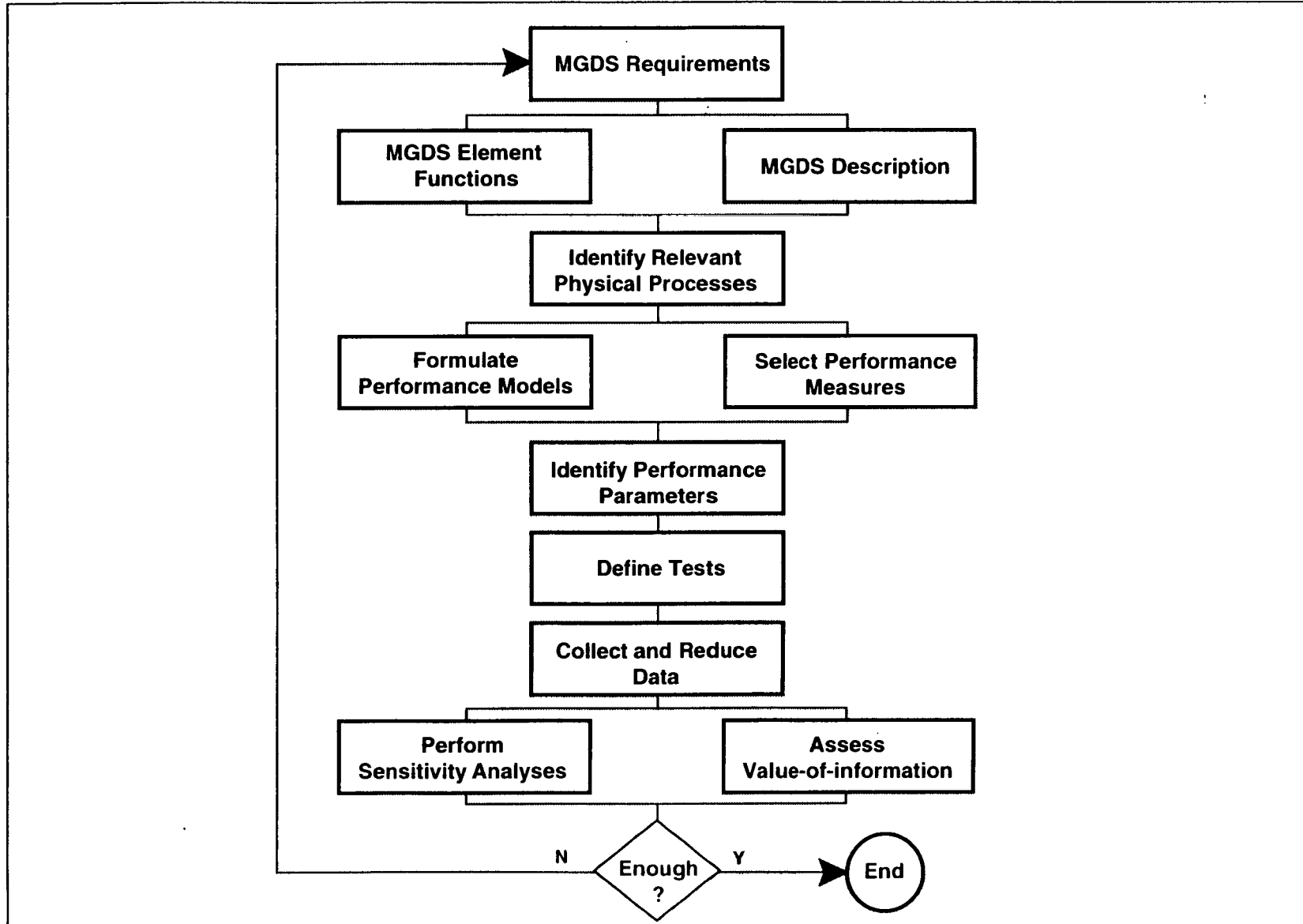
# Multiple-Barrier Concept (Yucca Mountain Repository)



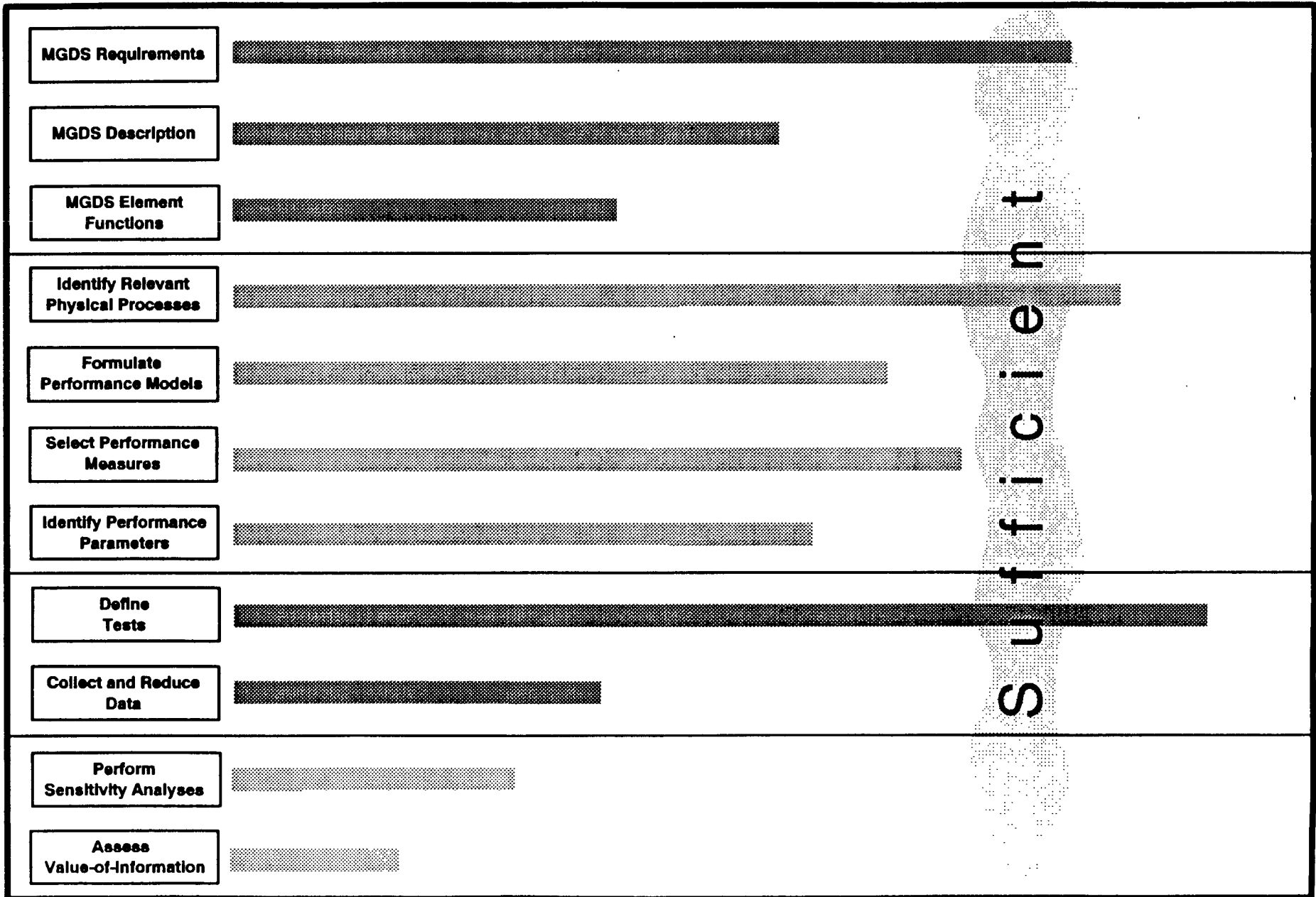
# **Mapping Information Flow: an Approach**

- **Follow through on SCP process**
- **Provide traceability through systems engineering**
- **Provide transparency for informed observers**

# Site Characterization Plan (SCP) Application of System Engineering



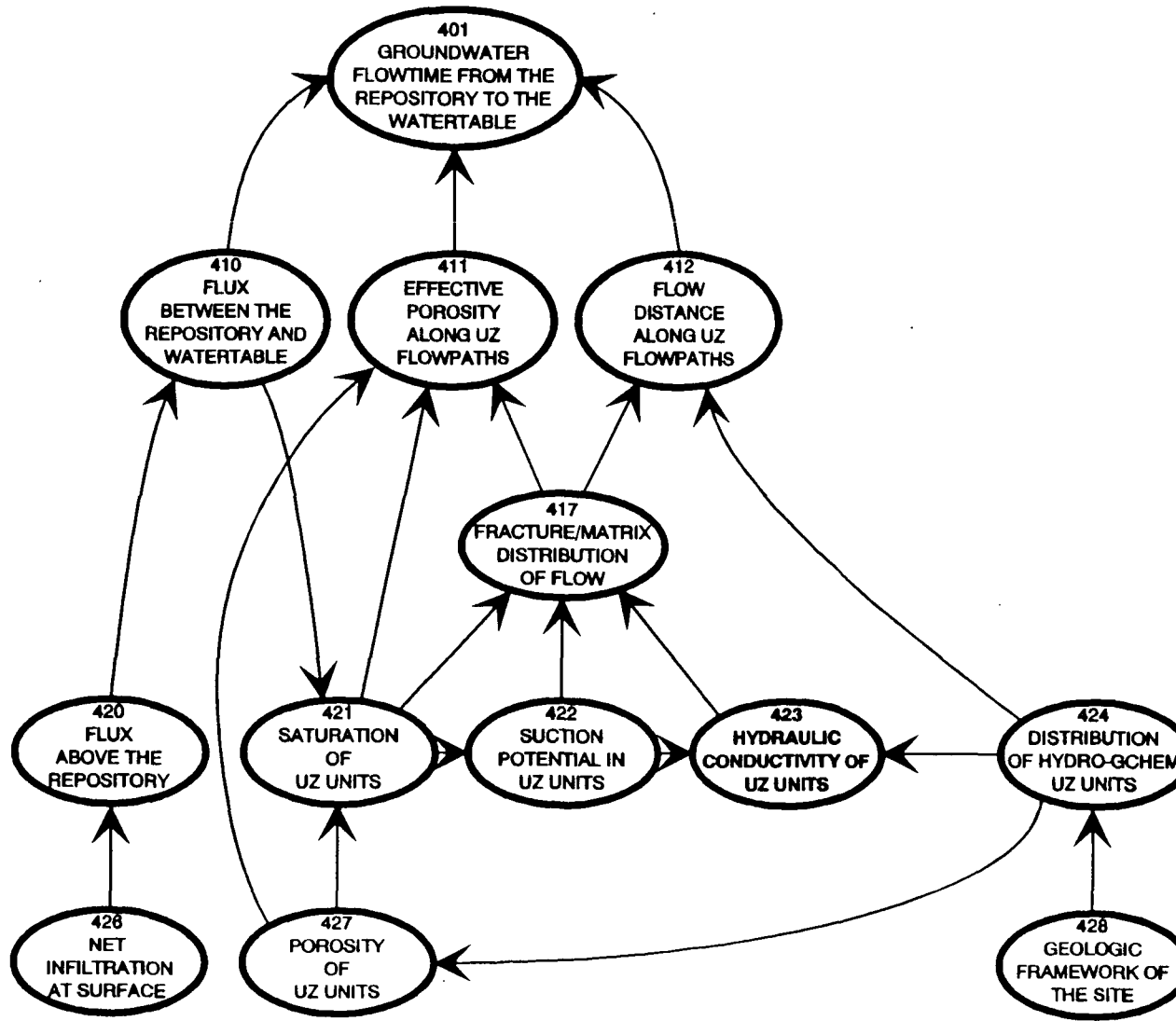
# Relative Progress: an Opinion





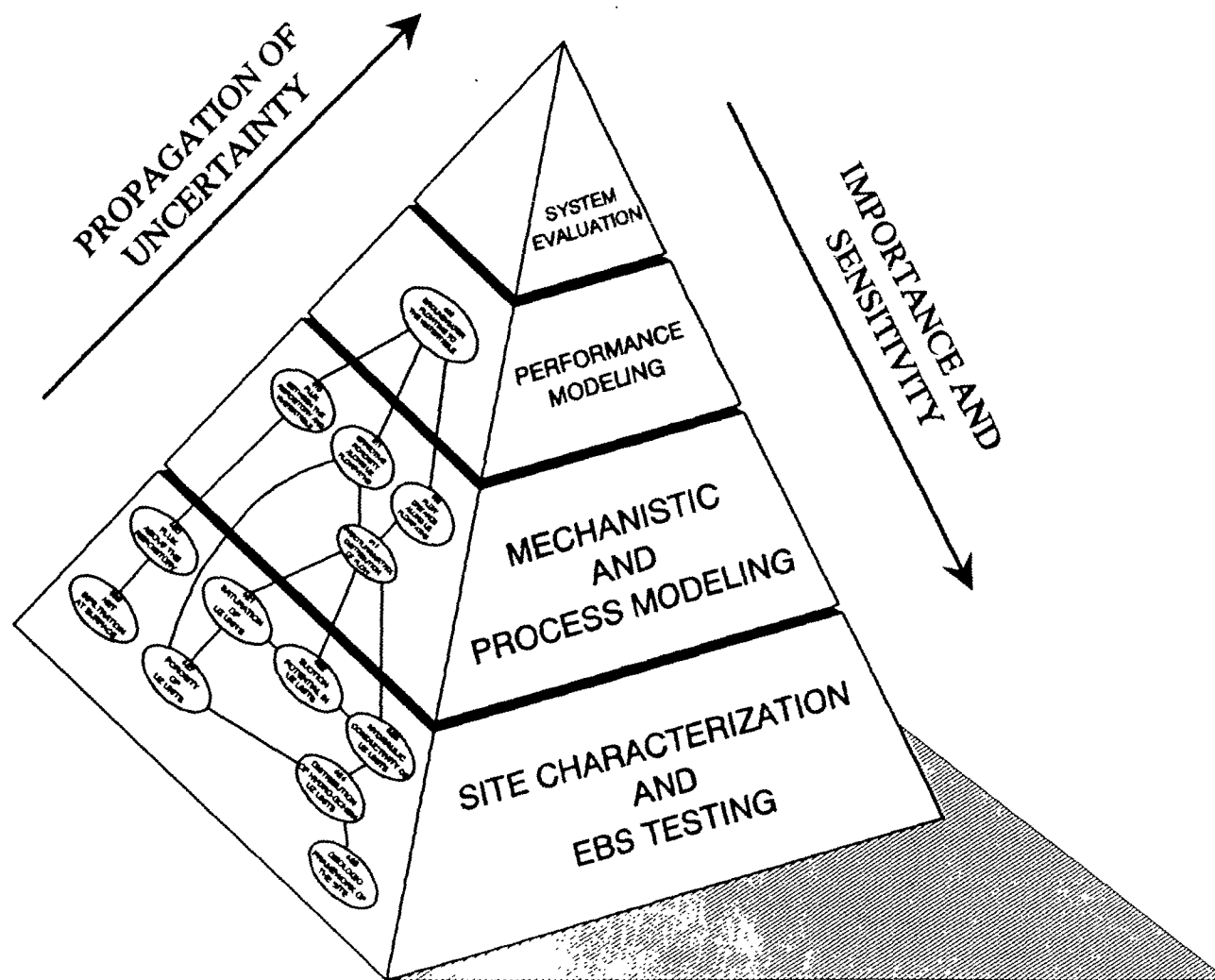
# Influence Diagram

## Relating Performance Measure to Site Data



see modeling pyramid  
for context

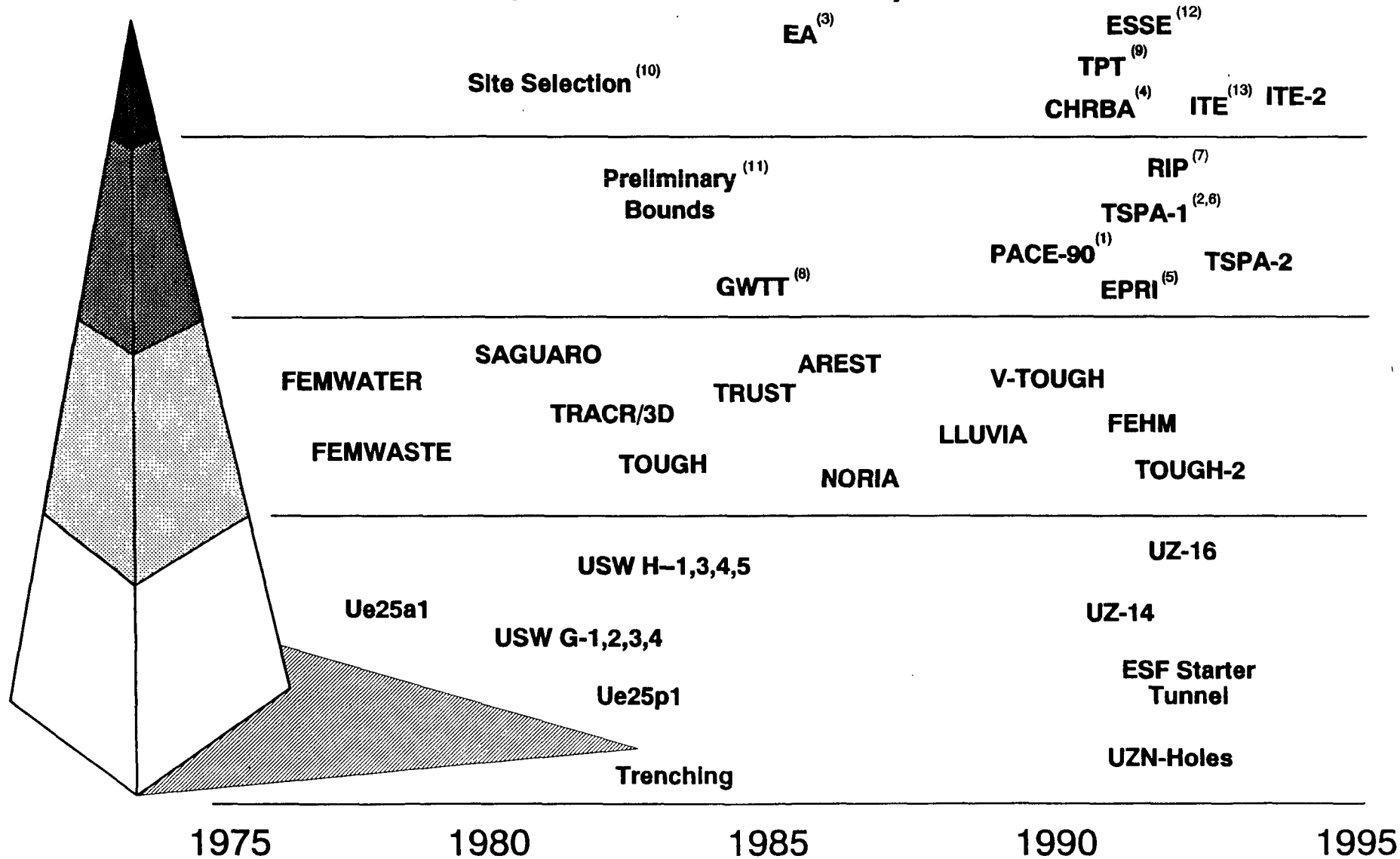
# Tracing Information Through the Pyramid



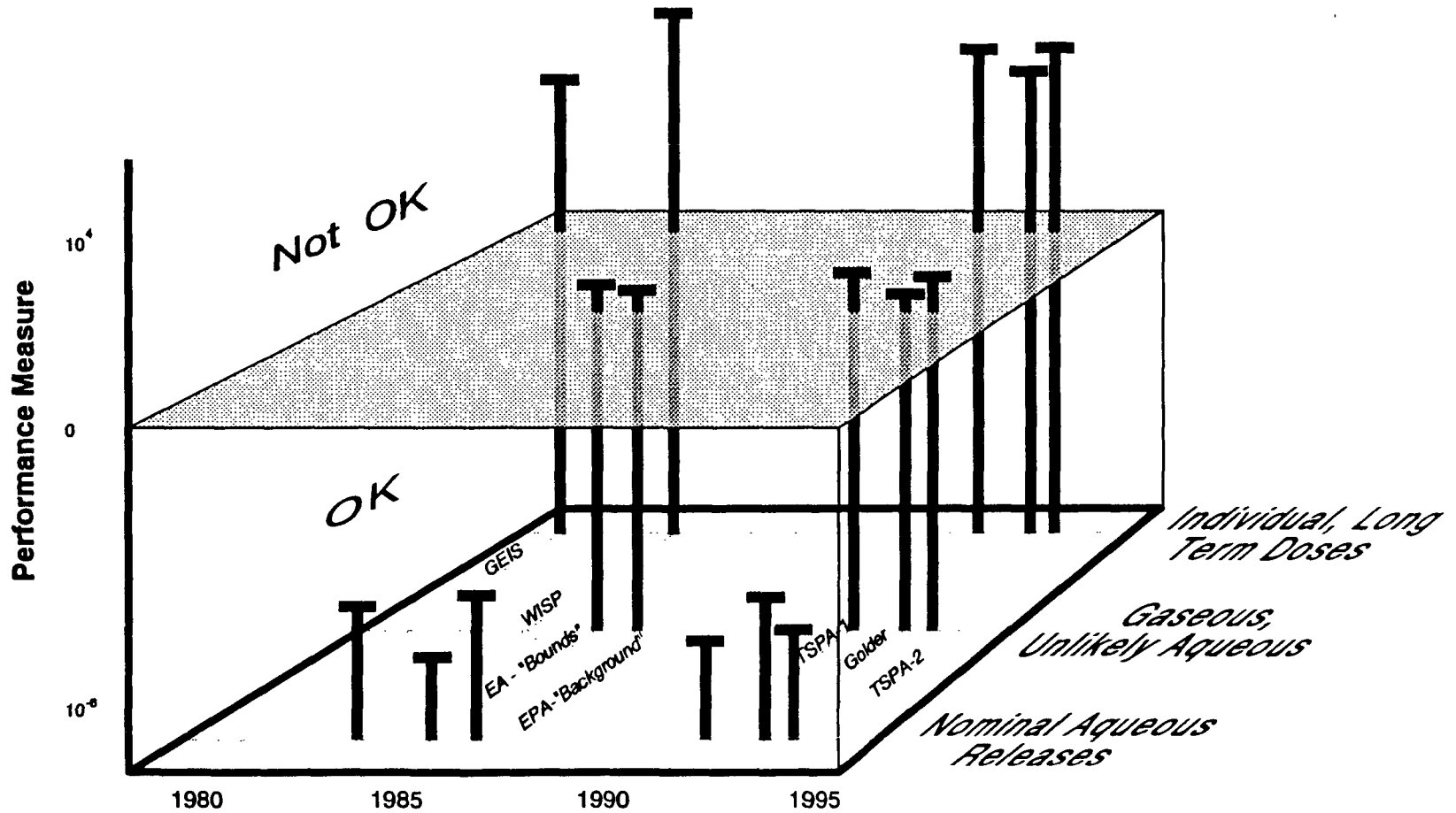
# History of Assessments

- **Assessments at different levels of the information pyramid**
- **Perspective on results**

# Yucca Mountain Project Pyramid (Selected Events)



# Performance Conclusions (Selected Analyses for Tuff)



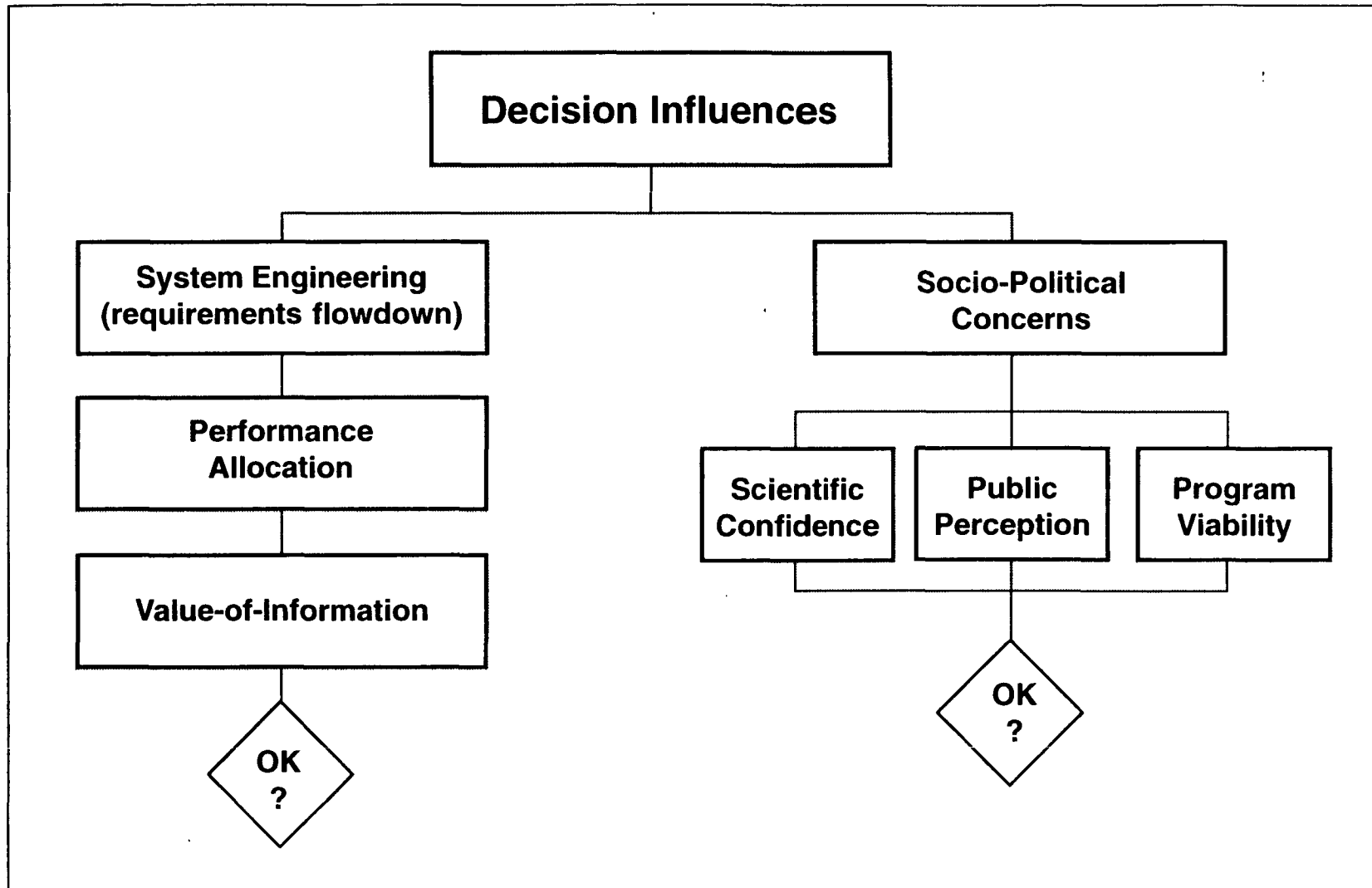
# Yucca Mountain Assessments: Summary

- **Multiple barriers interact to *delay* releases**
- **Individual barriers will delay different waste elements for different time periods**
- **No barriers will prevent potentially significant doses for very long times (>100,000s yrs)**

# Summary

- **Calculational tools are in place**
- **Data are rapidly becoming available**
- **Consistent performance results indicate robust behavior**
- **“Confidence” issue needs to be confronted**

# Closure Criteria





## Selected Performance Assessment and Site Evaluation Documents for Yucca Mountain

- 1 Barnard, R. W. and H. A. Dockery, 1991, Technical Summary of the Performance Assessment Calculational Exercises for 1990 (PACE-1990), Volume 1: Nominal Configuration Hydrogeologic Parameters and Calculational Results, SAND90-2726, Sandia National Laboratories, Albuquerque, NM.
- 2 Barnard, R. W., M. L. Wilson, H. A. Dockery, J. H. Gauthier, P. G. Kaplan, R. R. Eaton, F. W. Bingham, T. H. Robey, 1991. TSPA 1991: An Initial Total-System Performance Assessment for Yucca Mountain, SAND91-2795, Sandia National Laboratories, Albuquerque, NM.
- 3 DOE (U.S. Department of Energy), 1986. Final Environmental Assessment: Yucca Mountain Site Nevada Research and Development Area, Nevada, DOE/RW-0073, Washington, D.C.
- 4 DOE (U.S. Department of Energy), 1991. Risk/Benefit Analysis of Alternative Strategies for Characterizing the Calico Hills Unit at Yucca Mountain, Record Memorandum YMP/90-3, 2 volumes, Yucca Mountain Project Office, Las Vegas, NV.
- 5 EPRI (Electric Power Research Institute), 1992, Demonstration of a Risk-Based Approach to High-Level Waste Repository Evaluation: Phase 2, Report TR-100384, Palo Alto, CA.
- 6 Eslinger, P. W., L. A. Doreums, D. W. Engel, T. B. Miley, M. T. Murphy, W. E. Nichols, M. D. White, D. W. Langford, S. J. Ouderkirk, 1993. Preliminary Total-System Analysis of a Potential High-Level Nuclear Waste Repository at Yucca Mountain, PNL-8444, Pacific Northwest Laboratory, Richland, Washington.
- 7 Kossick, R. and I. Miller, 1993, Preliminary Investigation of Individual Dose-Based Performance Measures for the Proposed High Level Radioactive Waste Repository At Yucca Mountain, Nevada, Golder Associates, Report 923-1196, Redmond, WA, unapproved draft dated August 17, 1993, prepared for Electric Power Research Institute, Menlo Park, CA, cited with permission from B. Williams, EPRI.
- 8 Lin, Y. T., and M. S. Tierney, 1986. Preliminary Estimates of Groundwater Travel Time and Radionuclide Transport at the Yucca Mountain Repository Site, edited by S. Sinnock, SAND85-2701, Sandia National Laboratories, Albuquerque, NM.
- 9 Mattson, S.R., B. R. Judd, S. R. Sinnock, and D.T. Hoxie, 1991. Testing Priorities at Yucca Mountain: Recommended Early Tests to Detect Potentially Unsuitable Conditions for a Nuclear Waste Repository, YMP/91-25, Yucca Mountain Site Characterization Project Office, Las Vegas, NV.
- 10 Sinnock, Scott, and J. A. Fernandez, 1982. Summary and Conclusions of the NNWSI Area-To-Location Screening Activity, Report NVO-247, U. S. Department of Energy, Las Vegas NV.
- 11 Sinnock, S., Y. T. Lin, and J. P. Brannen, 1984. Preliminary Bounds on the Postclosure Performance of the Yucca Mountain Repository Site, Southern Nevada, SAND84-1492, Sandia National Laboratories, Albuquerque, NM.

- 12 Younker, J. L., W. B. Andrews, G. A. Fasano, C. C. Herrington, S. R. Mattson, R. C. Murray, L. B. Ballou, M. A. Revelli, A. R. Ducharme, L. E. Shephard, W. W. Dudley, D. T. Hoxie, R. J. Herbst, E. A. Patera, B. R. Judd, J. A. Docka, and L. D. Rickertsen, 1992. Report of Early Site Suitability Evaluation of the Potential Repository Site at Yucca Mountain, Nevada, SAIC-91/8000, Science Applications International Corporation, Las Vegas, NV.
- 13 Younker, J. L., S. R. Mattson, H. A. Dockery, W. W. Dudley, D. T. Hoxie, B. R. Judd, A. C. Matthusen, M. W. Pendleton, M. A. Revelli, E. P. Springer, A. E. Van Luik, 1992, Draft Final Report of the Integrated Test Evaluation Framework for Prioritizing Tests for the Yucca Mountain Site Characterization Project, transmitted to U.S. Department of Energy, TRW letter # LV.SY.JLY.11/92-047, November 13, 1992.
- 14 U. S. Environmental Protection Agency, 1985, Background Information Document, Final Rule for High-Level and Transuranic Radioactive Waste, U.S. EPA, Office of Radiation Programs, Washington DC, August 1985.
- 15 Waste Isolation Systems Panel, 1983, A Study of the Isolation System for Geologic Disposal of Radioactive Wastes, National Research Council Board on Radioactive Waste Management, National Academy Press, Washington, DC.
- 16 Undetermined Author, 1994, Total System Performance Assessment-1993, being written
- 17 DOE (U.S. Department of Energy), 1980, Final Environmental Impact Statement, Management of Commercially Generated Radioactive Waste, DOE/EIS-0046F, Washington, DC.

REFERENCE	DOCUMENT	MEASURE	AMOUNT	MAJOR NUCLIDES	NOTES	
<b>NOMINAL AQUEOUS RELEASES</b>						
15	p. 278	WISP	EPA Table	"below standard"	unknown	estimated based on long GWTT
11	p. 39	EA "Bounds"	EPA Table	$< 10^{-5}$	C <sup>14</sup> , I <sup>129</sup>	congruent leaching
14	p. 8-27	EPA "Background"	EPA Table	$< 10^{-3}$ @ p = .1	C <sup>14</sup> , I <sup>129</sup> , Tc <sup>99</sup>	"NRC standard" source term
2	p. 4-82	TSPA-1	EPA Table	$10^{-4}$ - $10^{-5}$ @ p = .5	I <sup>129</sup> , Tc <sup>99</sup>	weeps model
16	NA	TSPA-2	EPA Table	$10^{-4}$ - $10^{-5}$ @ p = .5	I <sup>129</sup> , Tc <sup>99</sup>	weeps model
7	fig. 4-1	Golder RIP	EPA Table	$< 10^{-3}$ @ p = .2	I <sup>129</sup> , Tc <sup>99</sup>	elicited input data
<b>GASEOUS and UNLIKELY AQUEOUS RELEASES</b>						
11	p. 44	EA "Bounds"	EPA Table	1 - 10	Pu <sup>239</sup> , Pu <sup>240</sup>	fracture flow, high flux, low K <sub>d</sub>
14	p. 8-43	EPA "Background"	1000 Cancers	$10^3$ - $10^4$ cancers	unknown	fracture flow, high leach rate
2	p. 10-3	TSPA-1	EPA Table	1 - 10 @ p = .1	C <sup>14</sup>	gaseous releases
16	NA	TSPA-2	EPA Table	1 - 10 @ p = .1	C <sup>14</sup>	gaseous releases
7	fig. 4-1	Golder RIP	EPA Table	.1 - 1 @ p = .1	C <sup>14</sup>	gaseous releases
<b>LONGTERM (&gt; 100,000 yr) INDIVIDUAL DOSES</b>						
17	p. 5-82	GEIS	170 mrem/yr	$10^0$ - $10^1$ rem	Ra <sup>226</sup>	generic "non salt" repository
15	p. 264	WISP	$10^{-4}$ Sv/yr	$10^1$ - $10^2$ Sv	Np <sup>237</sup>	> 100,000 yr
6	p. 10.11	TSPA-1	unknown	$10^2$ - $10^3$ rem	Np <sup>237</sup>	> 100,000 yr
16	NA	TSPA-2	unknown	$10^1$ - $10^2$ rem	Np <sup>237</sup>	> 100,000 yr
7	fig. 4-2	Golder RIP	unknown	$10^0$ - $10^1$ rem	Np <sup>237</sup>	> 100,000 yr