

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

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

SUBJECT: THE CALICO HILLS SYSTEM STUDY

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**LAS VEGAS, NEVADA
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Background

- **Site Characterization Plan (DOE 1988) called for “A risk/benefit analysis and selection of appropriate test option...before the initiation of testing.”**
- **Calico Hills Risk/Benefit Analysis published January 1991 (Results presented to NWTRB, March 1991)**
 - **Evaluated options for Calico Hills characterization**
 - **Multiattribute utility approach favored options that called for extensive drifting across the repository area**

Background

(Continued)

- **FY95 Calico Hills Study (In progress; May '95 planned completion date)**
 - **Re-evaluate data needs and access options relative to Program Approach**
 - **Determine how access options satisfy data needs**

Agenda

- **Study scope**
- **Decision process**
- **Potential data needs identified**
- **Performance assessment studies**
- **Access options**
- **CHn access option assessment**

Calico Hills Study Scope

Purpose:

Provide and evaluate options for when, where, and how to access the CHn via boreholes and/or drifting

Approach:

Define a logical process for making a CHn access decision

Establish CHn potential data needs based on site suitability and licensing requirements

Evaluate methods of accessing CHn based on ability to provide needed data, cost/schedule constraints, test interference, and risk to site performance

Calico Hills Decision Process

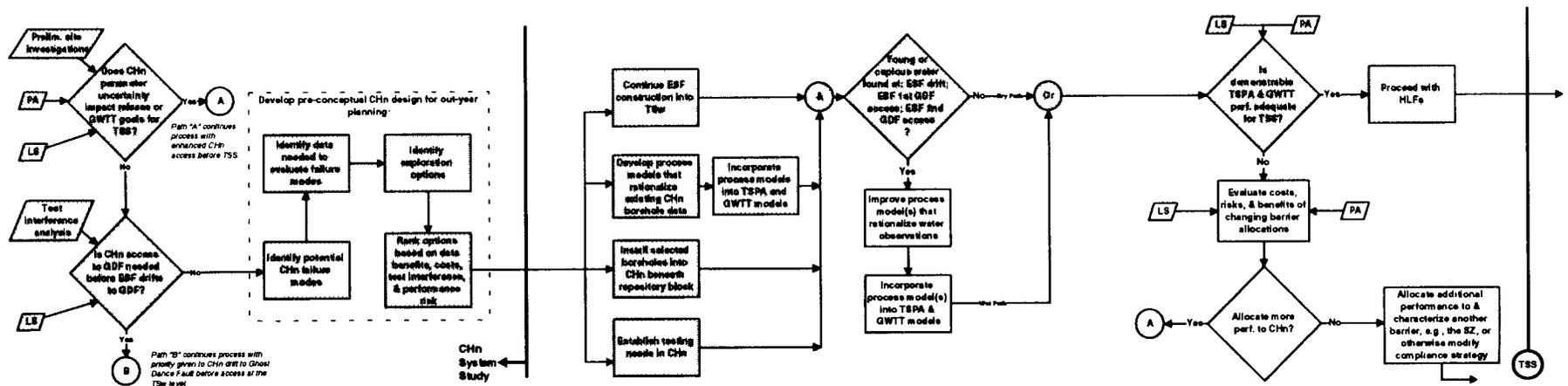
Purpose:

Define a logical process for the CHn access decision

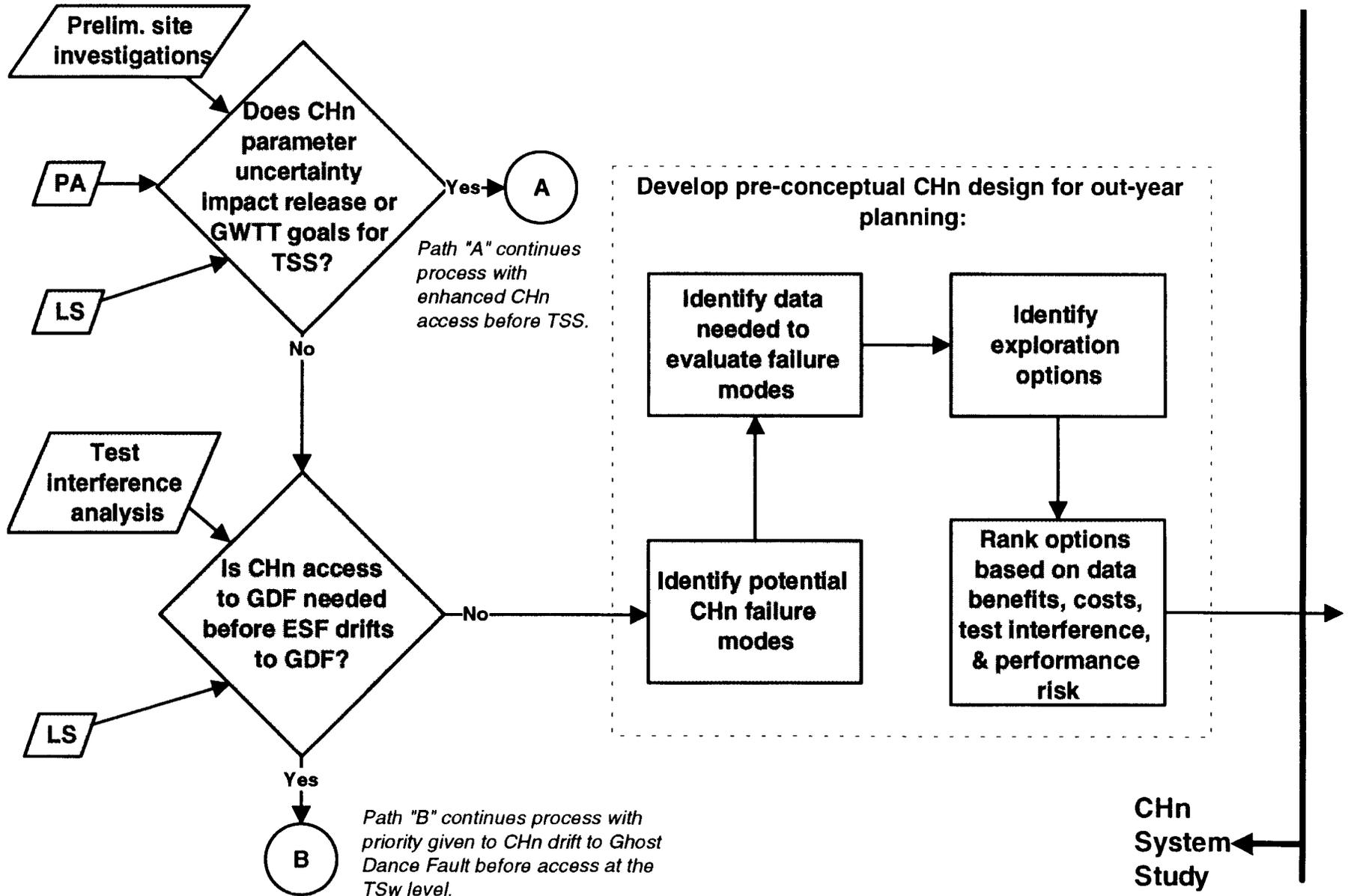
Assumption:

Waste isolation strategy utilizes defense-in-depth philosophy

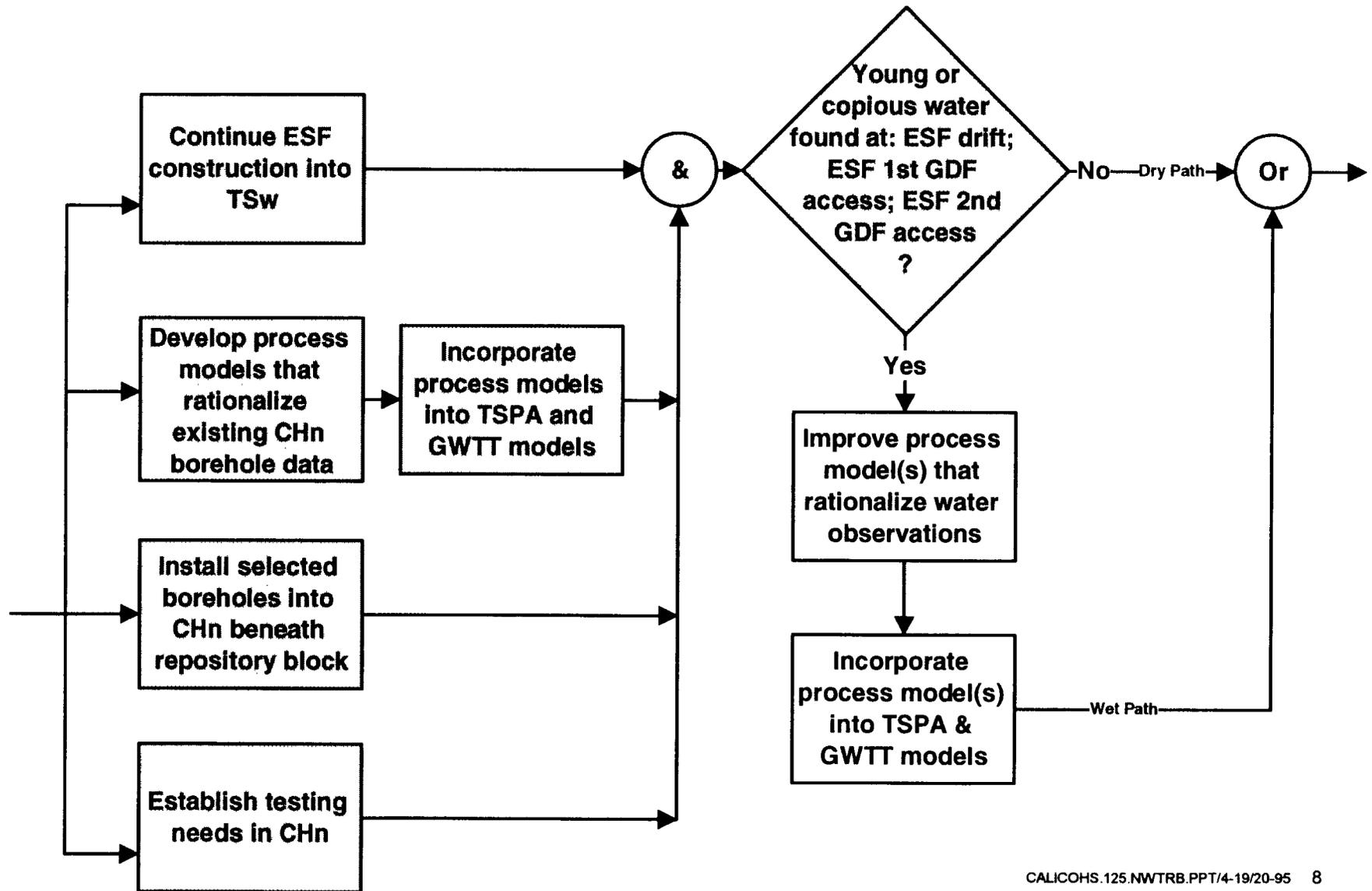
Program CHn Decision-Aiding Process: Overview



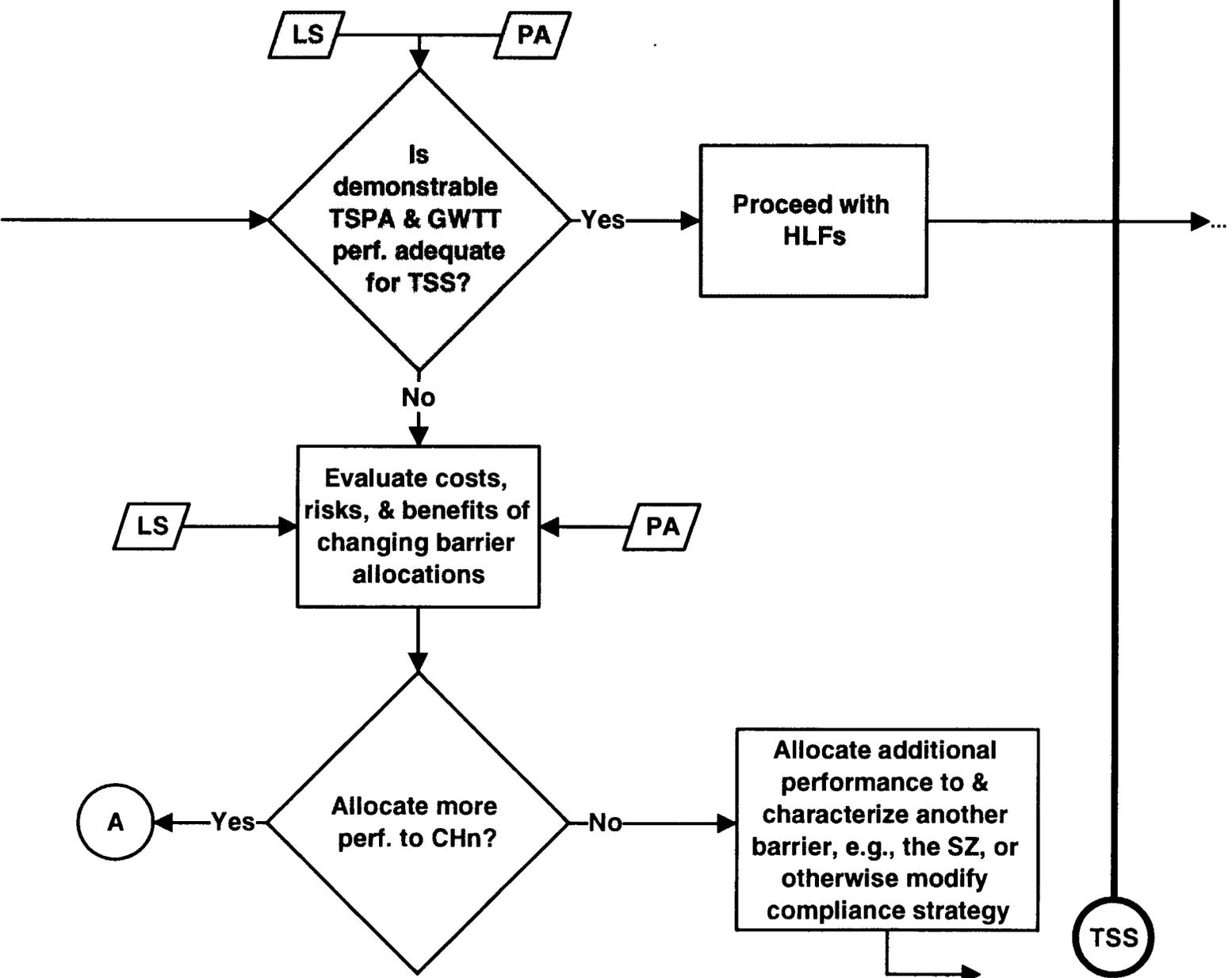
Program CHn Decision-Aiding Process



Program CHn Decision-Aiding Process



Program CHn Decision-Aiding Process



Potential Data Needs Identification

- **Goal: Identify and prioritize CHn potential data needs to support site-suitability evaluation and licensing**
- **Approach:**
 - **Utilize conditional failure modes as an intermediate step to identify potential data needs**
 - » **Conditional failure mode: feature, condition, or property that could degrade the ability of the CHn unit to adequately function as a geologic barrier**
 - **Potential data needs identified to determine occurrences of each conditional failure mode**

Conditional Failure Modes

- 1. Preferential flow and transport pathways: fractures and faults**
- 2. Inadequate physical retardation: matrix diffusion and imbibition into the rock matrix**
- 3. Inadequate retardation potential: geochemical (ion-exchange capability, surface complexation, etc.)**
- 4. Preferential flow and transport pathways: rock matrix**
- 5. Lateral diversion of groundwater above the CHn unit**
- 6. Repository-induced alteration of CHn properties: thermal and chemical effects**

Potential Data Needs to Determine Occurrence of Conditional Failure Mode: Example

- **Conditional failure mode**
 - **Inadequate physical retardation: matrix diffusion and imbibition into rock matrix**
- **Potential data needs**
 - **Rock-matrix hydrologic properties: porosity, hydraulic conductivity, moisture-retention & relative-permeability relations, including spatial correlation parameters**
 - **Rock-matrix hydrologic conditions: Measures of *in situ* saturation and water potential**
 - **Fracture-matrix interaction: water movement in natural fractures under unsaturated conditions**

Performance Assessment Studies

- **Purpose: evaluate impact of CHn conditional failure modes and property uncertainties on system performance**
- **Sensitivity studies conducted on TSPA and GWTT impacts**
- **Measures of system performance considered**
 - **10,000 year cumulative release ***
 - **100,000 year cumulative release**
 - **10,000 year peak individual dose**
 - **1,000,000 year peak individual dose**
 - **1,000 year GWTT**

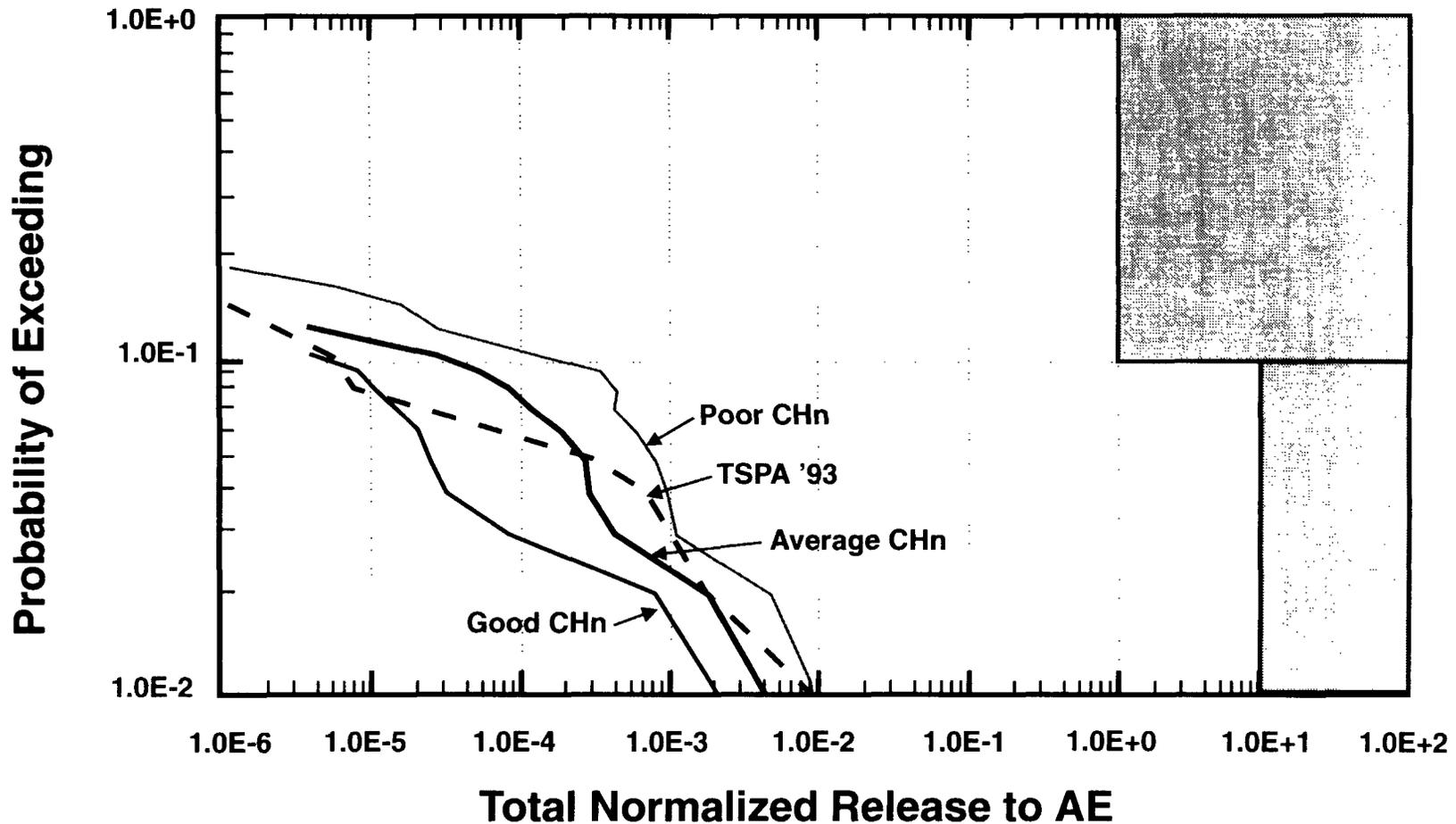
* Examples included in presentation

Performance Sensitivity to CHn Material Properties

- **Analysis conditions**
 - Matrix flow
 - TSPA-1993 base case
 - Good (90th percentile) Calico Hills: high K_d , high porosity
 - Average (50th percentile) Calico Hills: median K_d , median porosity
 - Poor (10th percentile) Calico Hills: low K_d , low porosity
 - No ¹⁴C in waste-form inventory
- **Conditional failure modes**
 - No. 3 Inadequate retardation potential: geochemical (ion exchange capability, surface complexation, etc.)
 - No. 6 Repository-induced alteration of CHn properties: thermal and chemical effects

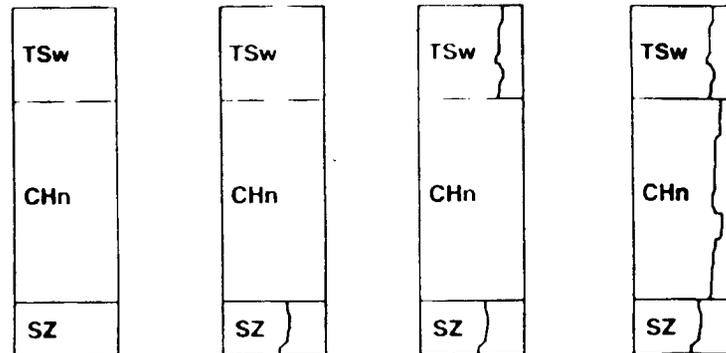
CCDF of Normalized Release at Accessible Environment over 10,000 Years (Matrix Flow)

Calico Hills Sensitivity Study

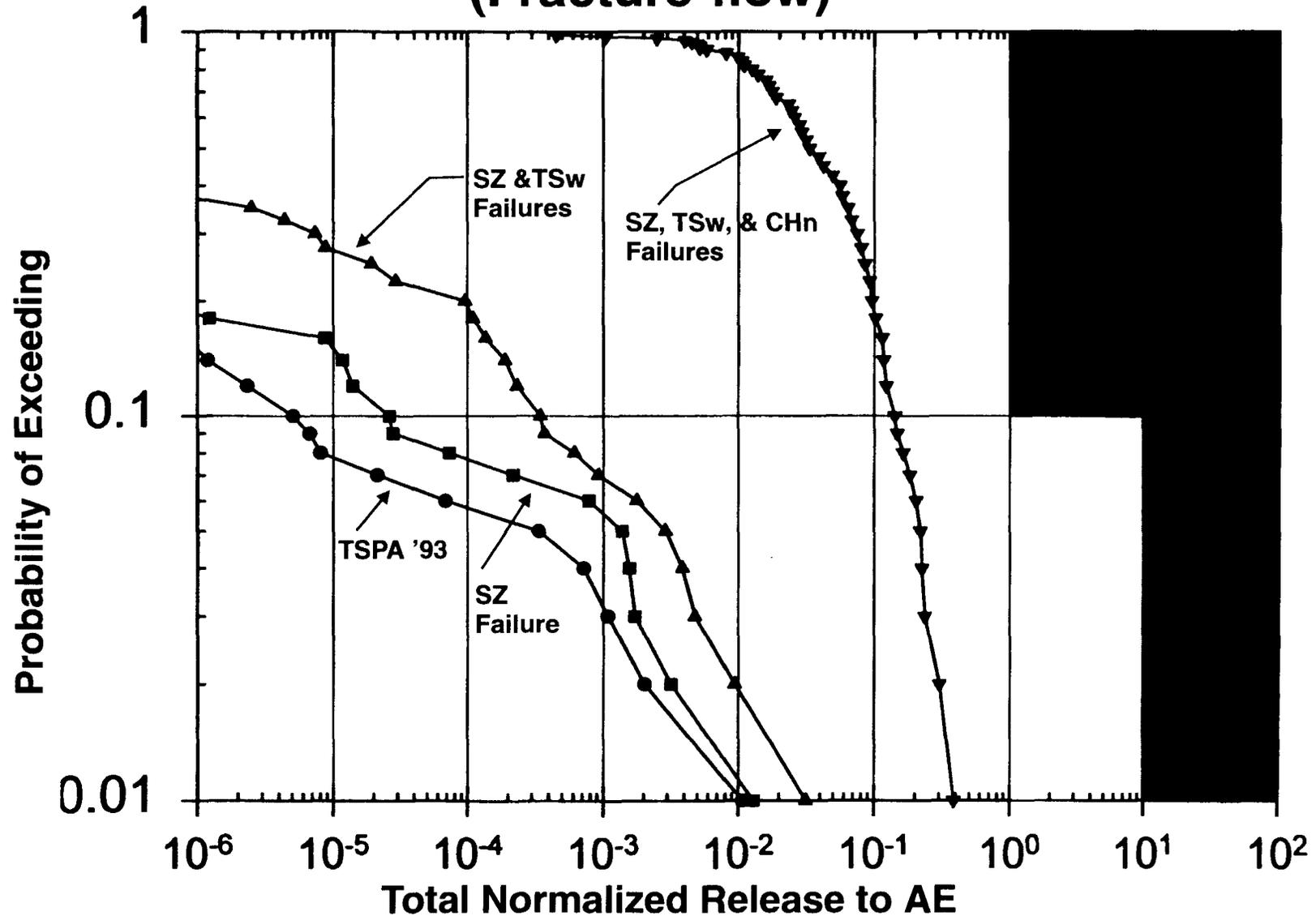


Preferential Pathway Failure

- **Analysis conditions**
 - Fracture flow and transport
 - TSPA-1993 base case
- **Conditional failure modes**
 - **No. 1** Preferential flow and transport pathways: fractures and faults
 - **No. 2** Inadequate physical retardation: matrix diffusion and imbibition into the rock matrix
 - **No. 4** Preferential flow and transport pathways: rock matrix
 - **No. 5** Lateral diversion of groundwater above the CHn unit
- **Failure of Individual units**



CCDF of Normalized Release at Accessible Environment over 10,000 Years (Fracture flow)



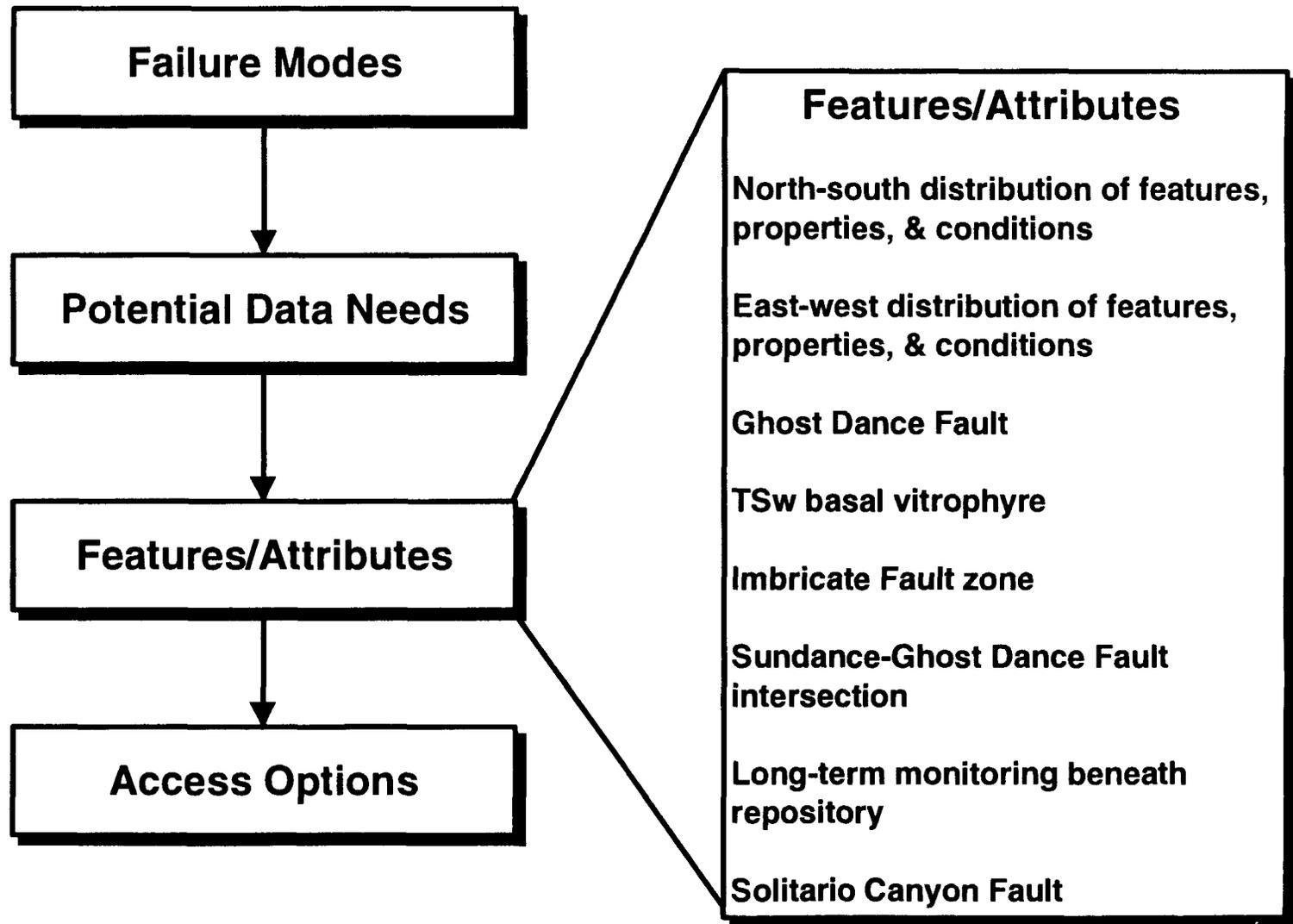
Summary of PA Studies

- **If matrix flow dominates flow into and through the CHn, system performance predictions will not be affected significantly by improved CHn properties characterization**
 - **Implies low priority for potential data needs of conditional failure modes requiring matrix flow**
- **For CHn to act as a poor barrier requires persistent fracture/fault flow and transport**
 - **Primarily an issue for GWTT and 10,000 year release/dose performance**
 - **Confirms significance of several of the conditional failure modes identified to develop potential data needs**
 - » **Major system sensitivity is to properties that address fracture/fault/lateral diversion conditional failure modes**
- **Implications of additional PA results under review**

Access Options

- **Boreholes**
- **Drifting**
- **Drifting plus boreholes**

Access Option Development Process



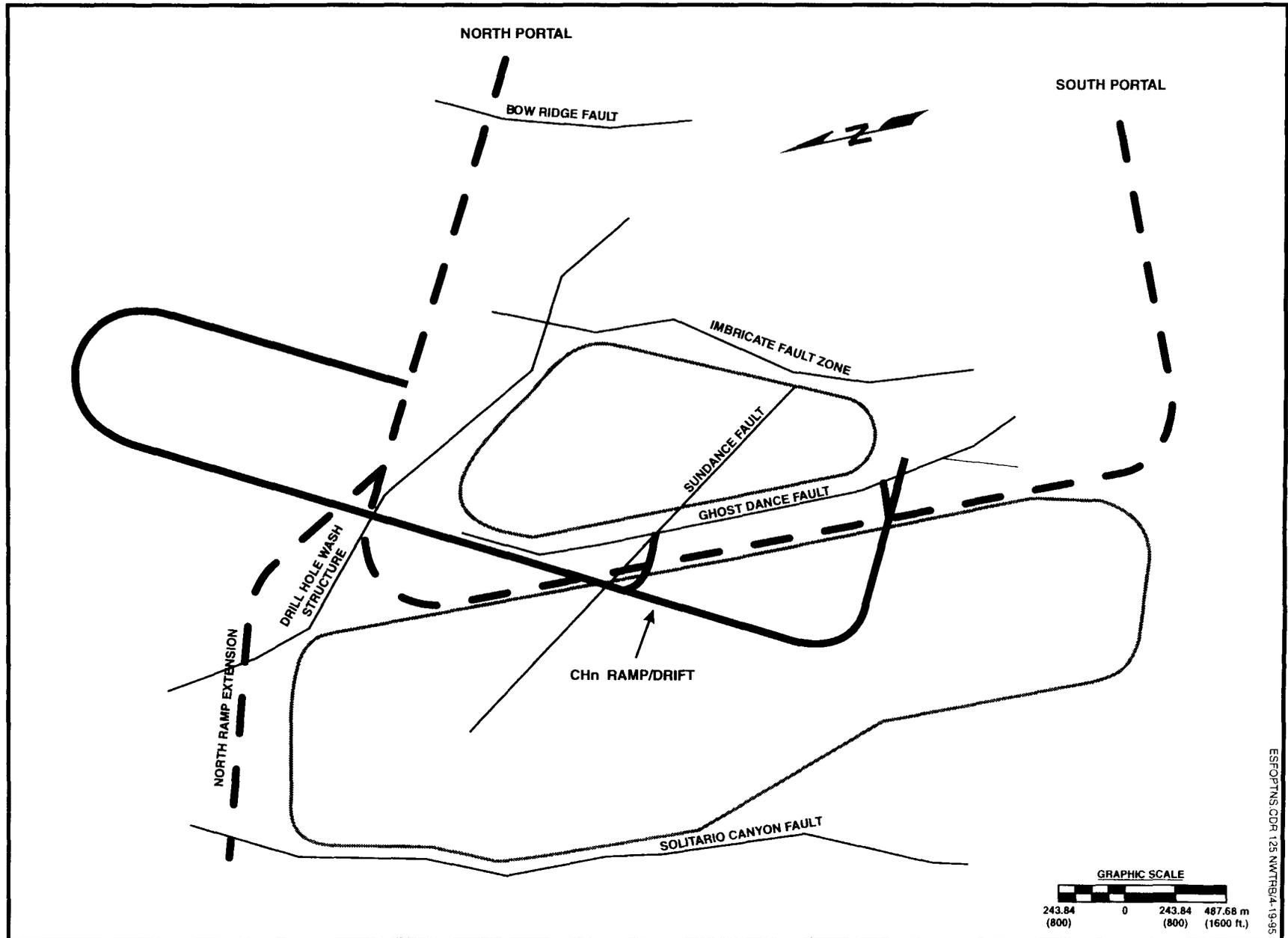
Excavation Options

- **Minimum Excavation**
 - Minimal drifting option
 - One fault accessed
- **Modified Base Case**
 - Moderate drifting option
 - Multiple fault accesses
- **Extensive Excavation**
 - Targets all major faults within or adjacent to the repository footprint
 - Extensive north-south drifting
 - Significant east-west drifting

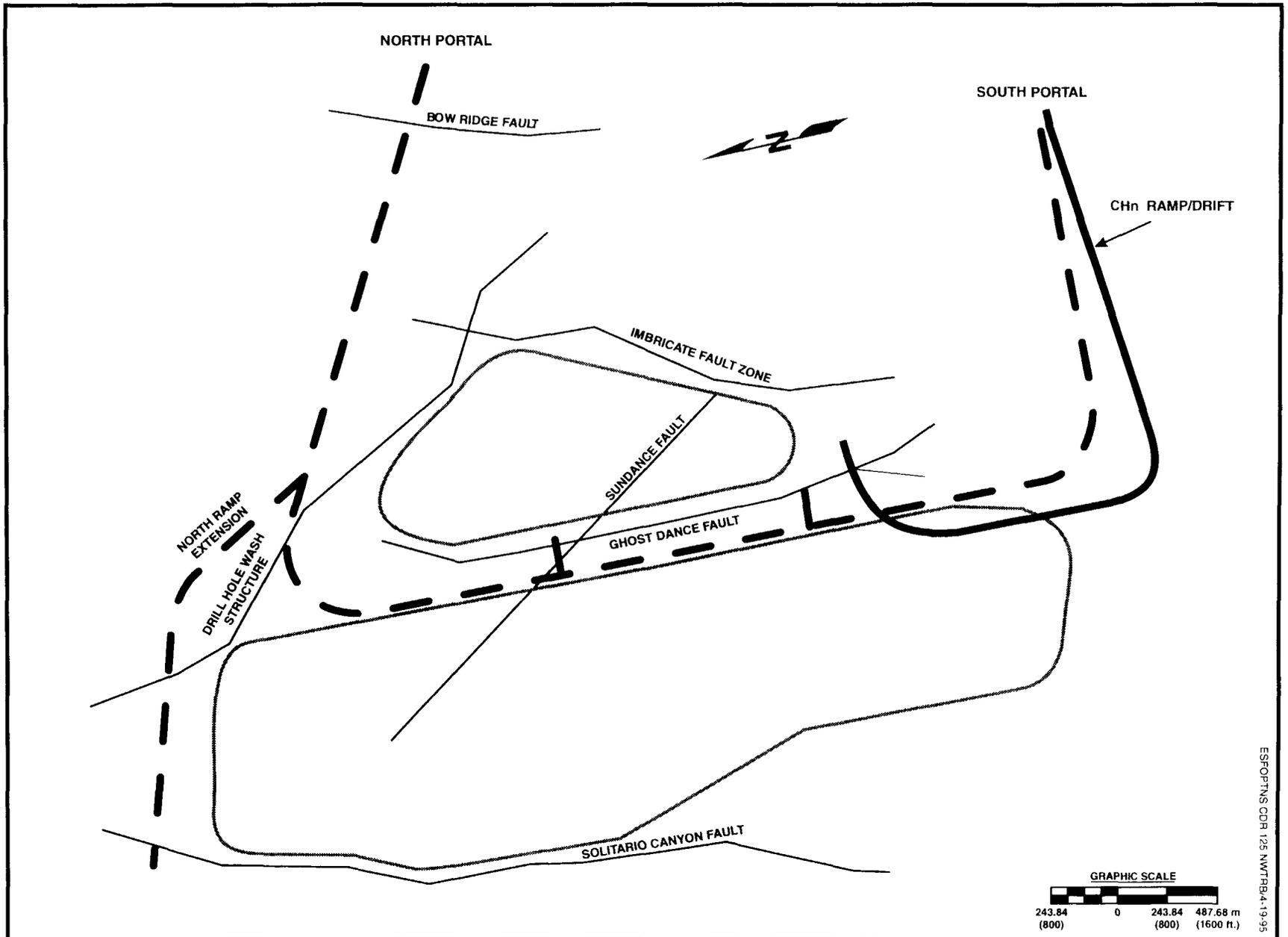
Access Option Features/Attributes

Access Option	Feature/Attribute								
	North-south distribution of features, properties & conditions	East-west distribution of features, properties, & conditions	Ghost Dance Fault access	TSW basal vitrophyre	Imbricate Fault zone	Sundance-Ghost Dance Fault Intersection	Long-term monitoring stations beneath repository	Drill Hole Wash structure	Solitario Canyon Fault
Boreholes	✓✓ vert	✓✓ vert	✓	✓✓✓	✓			✓	✓
Extensive excavation	✓✓✓ horiz	✓✓✓ horiz	✓✓✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Modified base case	✓✓	✓	✓✓✓	✓		✓✓✓	✓✓		
Minimum excavation	✓	✓	✓✓✓	✓			✓		

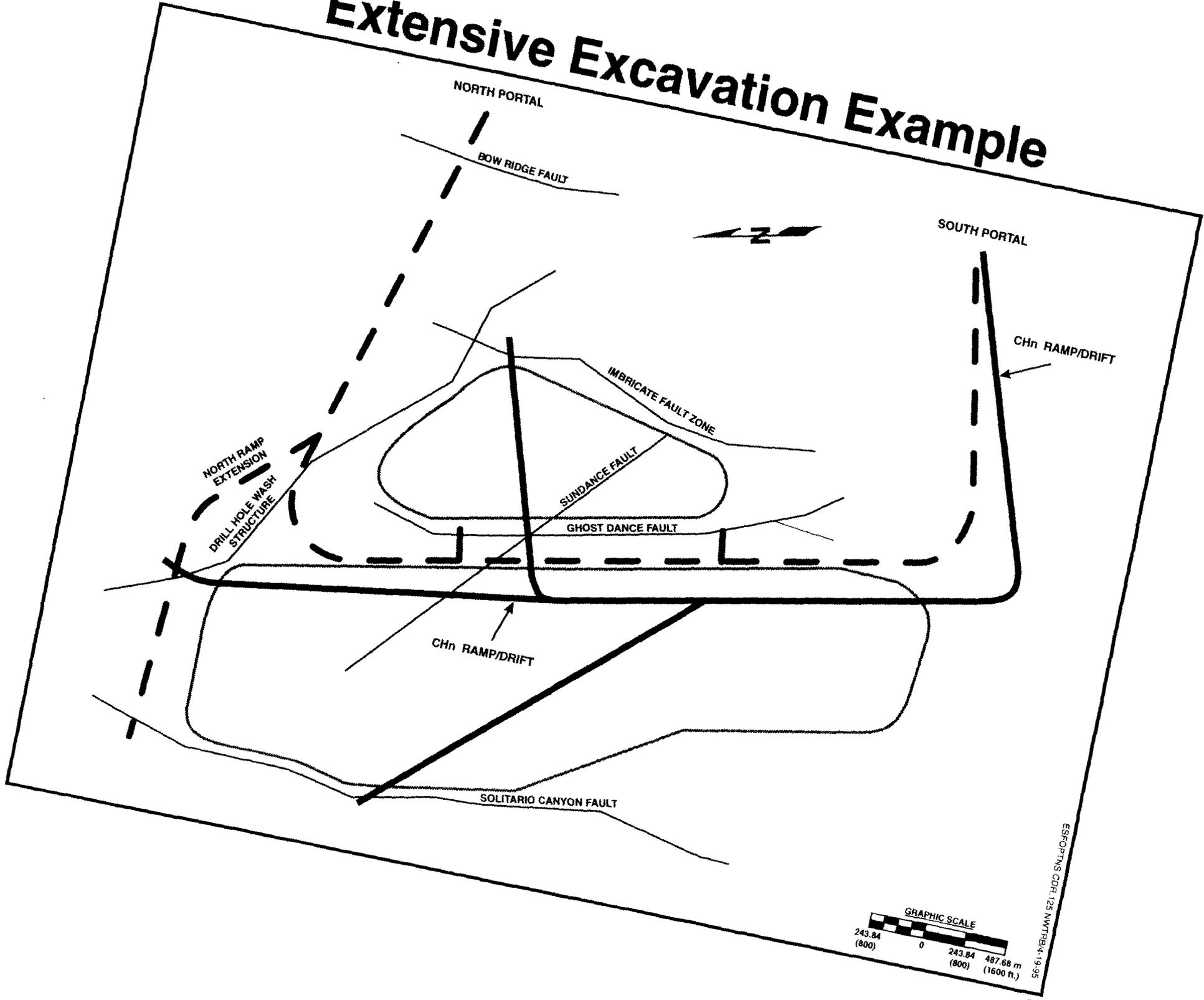
Modified Base Case Example



Minimum Excavation Example



Extensive Excavation Example



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Access Options Evaluated

- **Boreholes only, no drifting**
- **Modified base case, without new boreholes into CHn**
- **Modified base case (with boreholes)**
- **Minimum excavation option (with boreholes)**
- **Extensive excavation option (with boreholes)**
- **Extensive excavation option (with boreholes), GDF accessed in CHn before TSw**
- **Extensive excavation option (with boreholes), 110 year monitoring**

Calico Hills Exploration Option Assessment

- **Purpose:** to evaluate exploration options for ability to provide scientific understanding of Calico Hills performance
- **Approach:**
 - Used multi-attribute assessment procedure to evaluate scientific understanding gained
- **Currently compiling results (May '95 planned study completion date)**

Access Option Ranking

