

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

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

**SUBJECT: EXPLORATORY STUDIES FACILITY
GEOLOGIC CONDITIONS**

PRESENTER: DENNIS WILLIAMS

**PRESENTER'S TITLE
AND ORGANIZATION: DEPUTY ASSISTANT MANAGER, SCIENTIFIC PROGRAMS
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE**

TELEPHONE NUMBER: (702) 794-7968

**SALT LAKE CITY, UTAH
JULY 11-12, 1995**

Geology Data for ESF Design

- **Study Plan 8.3.1.14.2, *Soil and Rock Properties of Potential Locations of Surface and Subsurface Facilities*; Sandia National Laboratories (SNL)**
- **North Ramp Geotechnical Report, SAND-95-0488/1, includes both cross sections and geologic and geotechnical data developed by SNL with support from the USGS and the M&O design team**
- **Main Drift Geotechnical Report - July 1995**
- **South Ramp Geotechnical Report - FY 1996**

Geologic Data From ESF

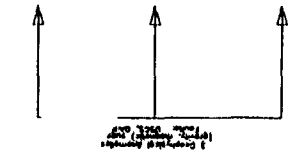
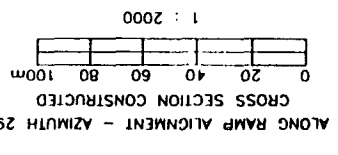
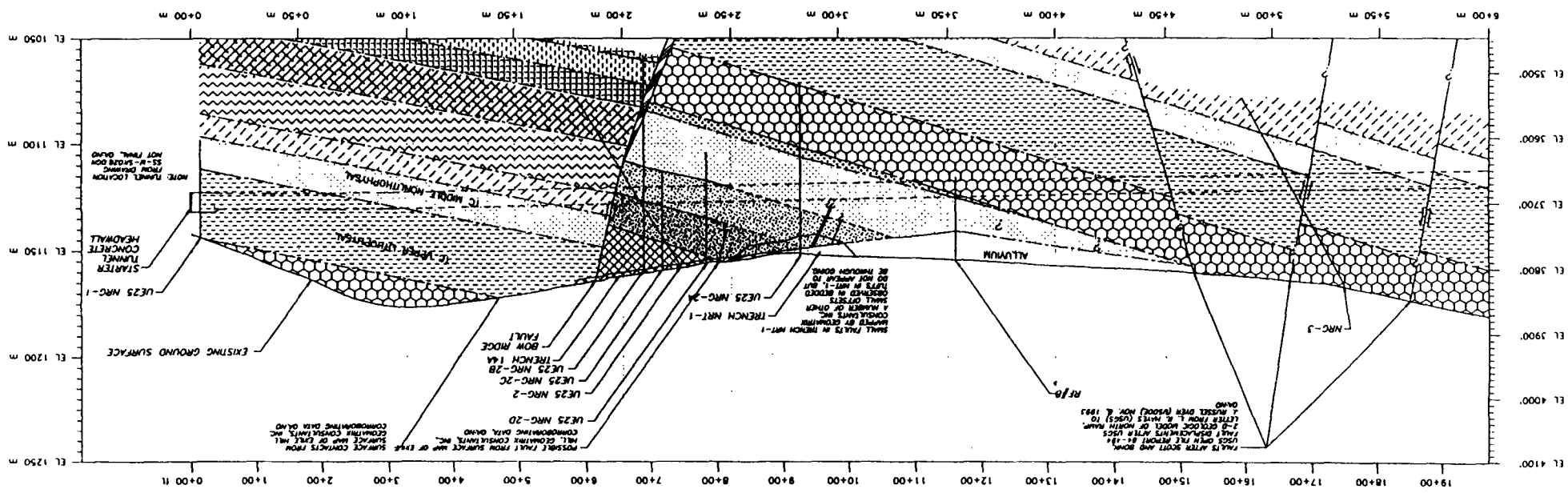
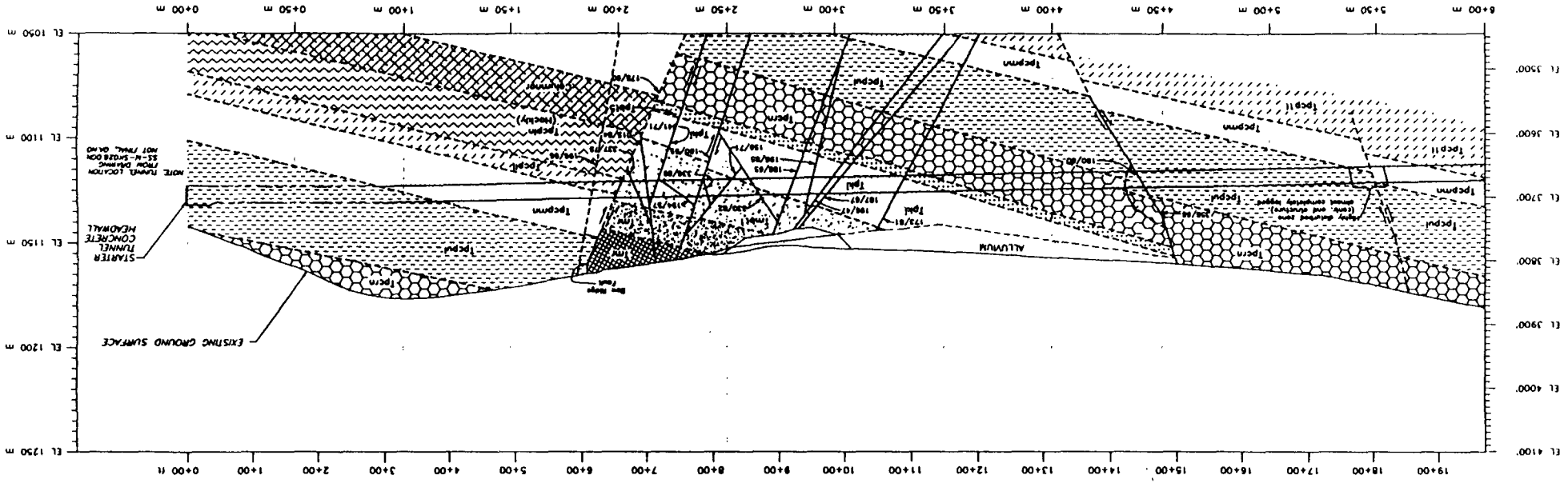
- **ESF mapping**
 - Detailed tunnel map to 4+00 was completed in June 1995
- **Construction monitoring**
 - Rock mass quality data is provided to designer and constructor as the tunnel is constructed

What Have We Learned?

- **Faults**
- **Stratigraphy**
- **Fractures**
- **Rock Mass Quality**

What Have We Learned?

- **Faults**
 - **As predicted, mapped faults are located in the tunnel to station 5+00; between 5+00 and 6+00 there is an apparent mismatch**



ALONG RAMP ALIGNMENT - AZIMUTH 299°

Faulting: Observations to 6+00

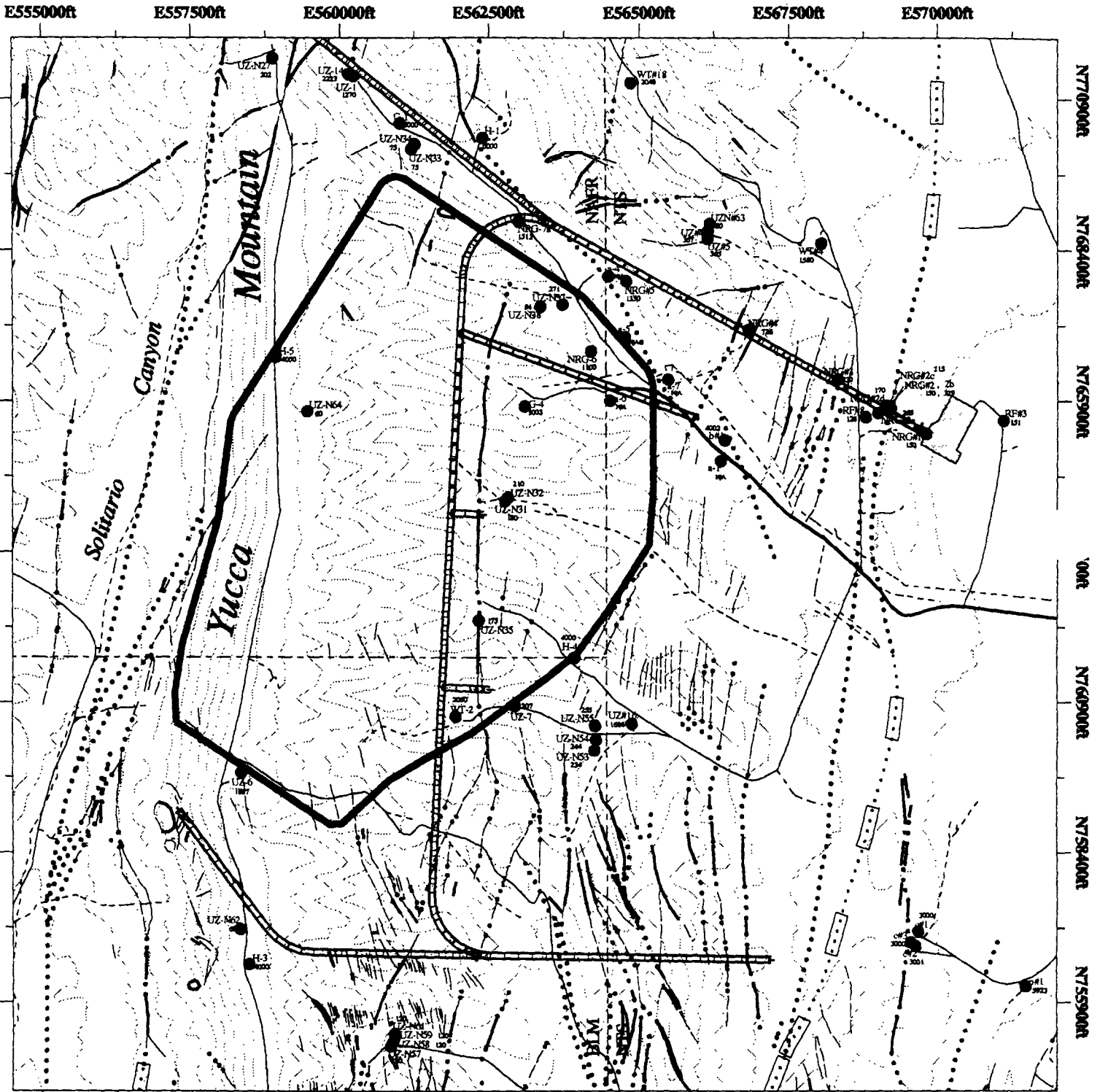
- **Faults with small offsets (<5m) between 5+00 and 6+00 have wide zones of disruption (may be as much as 20m) in densely welded tuff**
- **The fault shown at 5+50 in ESF mapping is based on very limited exposure due to lagging. It is not inconsistent with surface mapping data and is still a roughly north-trending normal fault as shown in prediction section**
- **No fault detected at 5+00, as shown in prediction cross-section**
- **Fault at 7+00 is high-angle normal fault, offset 15m down to west and fits general trend, but is not mapped at surface**
- **Additional surface mapping indicates there may be a northwest-trending fault near 5+50, which is consistent with observations in ESF (previously unmapped)**
- **Bow Ridge Fault (offset >100m) has limited zone of disruption (<5m)**

Imbricate Fault Zone

- **Zone(s) of closely spaced faults in eastern part of structural blocks in the Yucca Mountain area - Scott (1990) GSA Memoir 176**
- **Western edge of an imbricate fault zone forms the eastern margin of the repository lower block**

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

EXISTING BOREHOLES
with GEOLOGIC STRUCTURE



What Have We Learned?

- **Geology**
 - **Stratigraphic contacts are located in the tunnel, nearly as predicted**

Projected Ramp Station Coordinates at Stratigraphic Contacts Along North Ramp Alignment Tunnel Centerline

Stratigraphic Unit	Projected Ramp Sta. at Contact (m)	Projected Dist ² in Unit (m)
Tiva Canyon Tuff (Tpc)	0+00	196
Rainier Mesa Tuff (Tmr and Pre-Rainier Mesa Bedded Tuff (Tmbt1)	1+96	71
Tuff Unit "X" (Tpki) and Pre-Tuff Unit "X" Bedded Tuff (Tpbt5)	2+68	160 to 243
Tiva Canyon Tuff (Tpc) ¹	3+54 to 4+39	467 to 550
Pre-Tiva Canyon Tuff Bedded Tuff (Tpbt4)	8+90	<1
Yucca Mountain Tuff (Tpy)	9+00	20
Pre-Yucca Mountain Tuff Bedded Tuff (Tpbt3)	9+20	25
Pah Canyon Bedded Tuff (Tpbt)	9+45	83
Pre-Pah Canyon Tuff Bedded Tuff	10+28	34
Topopah Spring Tuff (Tpt)		
Crystal-rich nonlithophysal zone, crystal-rich vitric zone (Tptrn)	10+62	754
Crystal-rich upper nonlithophysal and crystal-poor upper lithophysal zones (Tpul)	18+16	947
Crystal-poor middle nonlithophysal zone (Tptpmn)	27+63	37

¹ Range reflects uncertainty due to possible faults under Daylight Valley. Distance given to where tunnel roof projected to intersect contact

² Inclined distance along ramp

ESF Tunnel Stratigraphy

	<u>Station</u>	
TCw	0+00 to 0+99.5m	Tiva Canyon crystal-poor upper lithophysal zone
	0+99.5 to 1+90m	Tiva Canyon crystal-poor middle nonlithophysal zone
	1+90 to 1+99.5m	Tiva Canyon crystal-poor lower lithophysal zone
	1+99.5 to 2+02m	Bow Ridge fault zone (placing Pre-Rainier Mesa Tuff against Tiva Canyon Tuff)
UO	2+02 to 2+20m	Pre-Rainier Mesa Tuff
	2+20	Fault (4.3m offset) ***
	2+20 to 2+63.5m	Pre-Rainier Mesa Tuff
	2+63.5 to 3+37m	Tuff "X"
	3+37 to 3+49.5m	Pre-Tuff "X"
	3+49.5 to 3+59.5m	Tiva Canyon crystal-rich nonlithophysal zone
TCw	3+59.5 to 4+30m	Tiva Canyon crystal-rich nonlithophysal zone
	4+30m	Fault (~10m offset) ***
	4+30 to 4+55.3m	Tiva Canyon crystal-rich nonlithophysal zone
	4+55.3 to 5+20m	Tiva Canyon crystal-poor upper lithophysal zone
	5+20 to 5+50m	Tiva Canyon crystal-poor middle nonlithophysal zone
	5+50m	Fault (~5m offset) ***
	5+50 to 5+87m	Tiva Canyon crystal-poor middle nonlithophysal zone
	5+87 to 6+17m	Tiva Canyon crystal-poor lower lithophysal zone
	6+17 to 7+00m	Tiva Canyon crystal-poor lower nonlithophysal zone
	7+00m	Fault (~20m? offset) ***
PTn	7+00 to 7+77m	Tiva Canyon crystal-poor lower nonlithophysal zone
	7+77 to 8+69m	Tiva Canyon crystal-poor vitric zone
	8+69 to 9+12m	Bedded tuffs (including thin Yucca Mountain member)
TSw1	9+12 to 10+20m **	Pah Canyon Member
	10+20 to 10+75m **	Pre-Pah Canyon tuffs
	10+75 to ?	Topopah Spring crystal-rich nonlithophysal zone

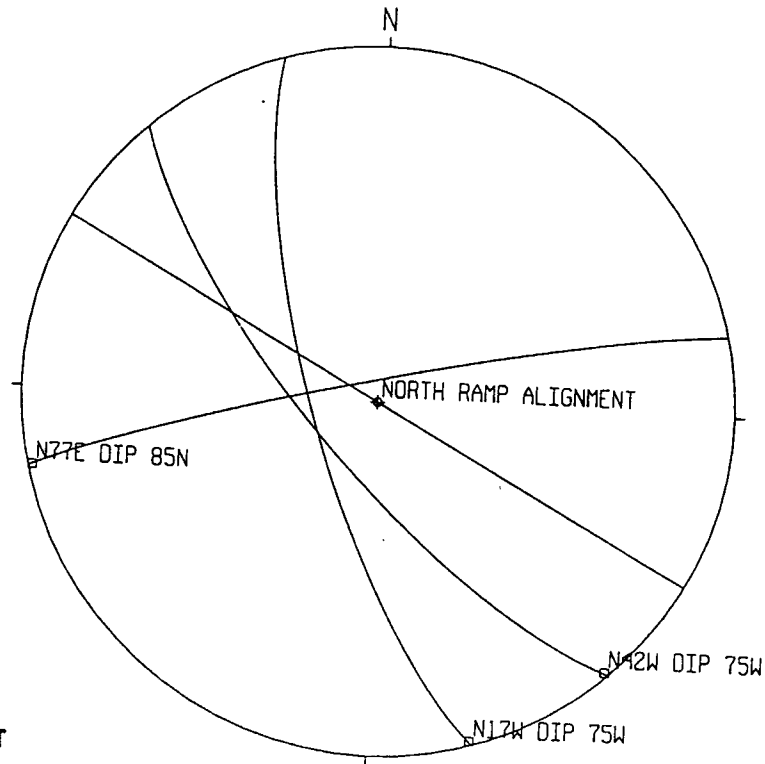
Note: All stations given are referenced to the right springline unless otherwise noted

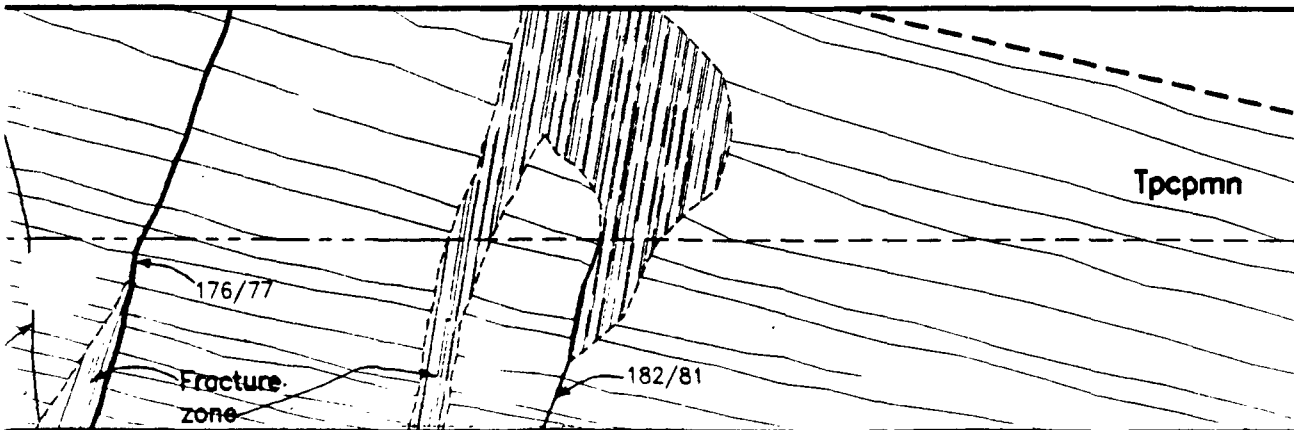
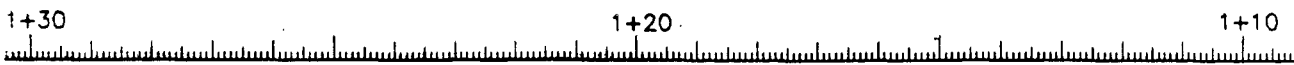
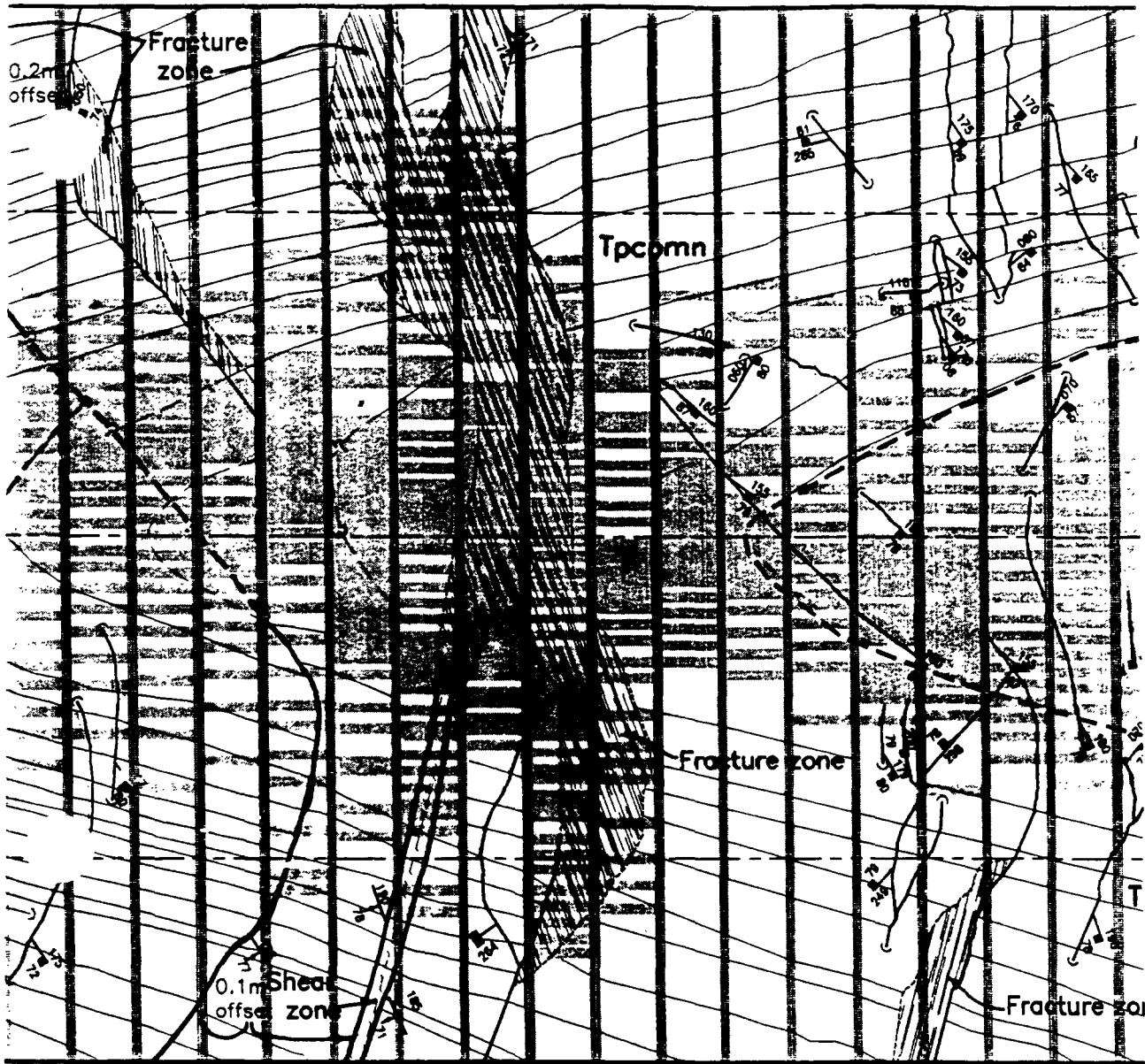
** Indicates that contact is preliminary and has not been verified

*** Only faults with greater than 4 meters offset are noted on the table

What Have We Learned ?

- **Fractures**
 - **Borehole and pavement data indicate the majority of fractures are steeply dipping. This has been confirmed by mapping in the ESF**





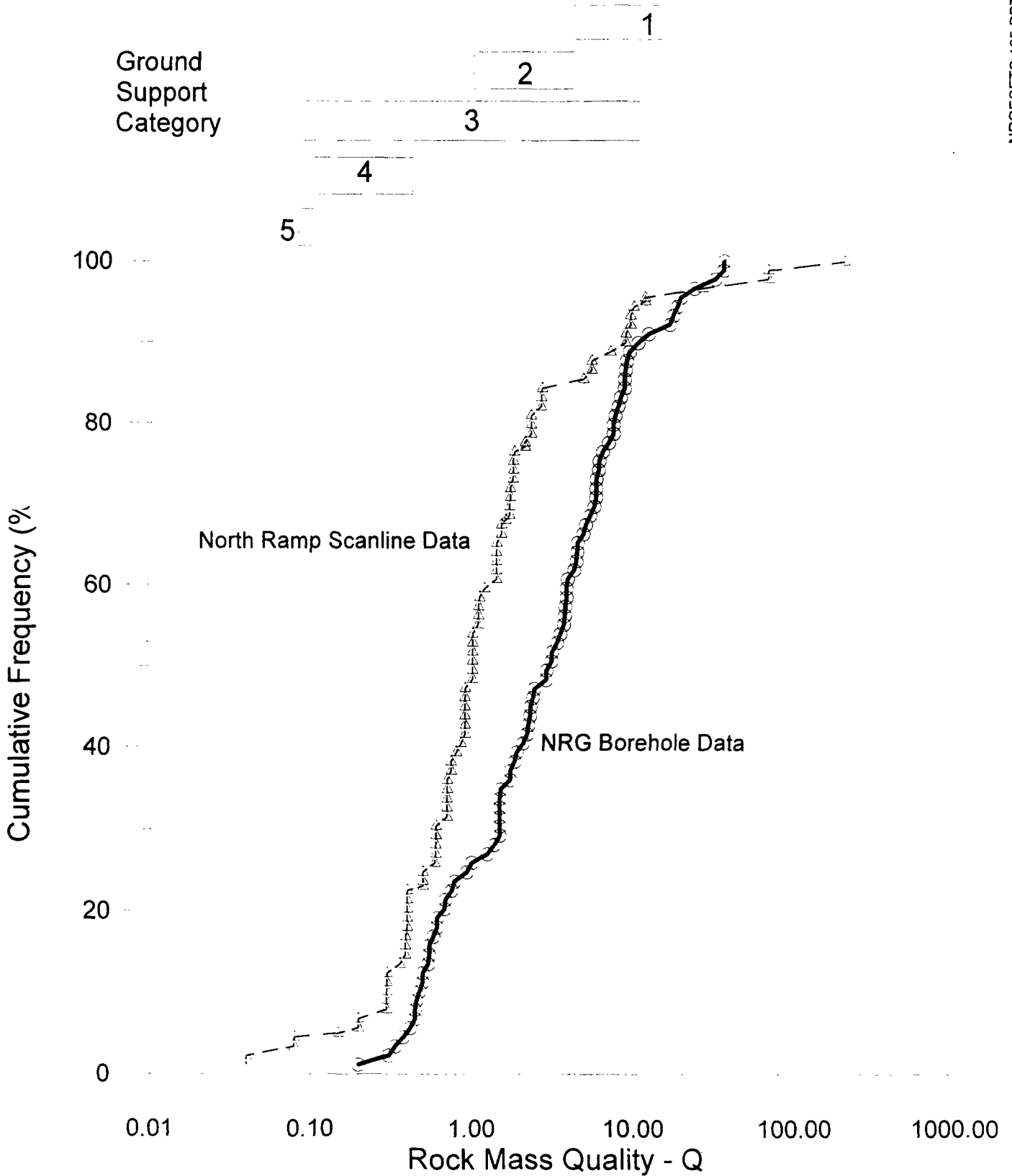
What Have We Learned ?

- **Rock Quality**
 - **Rock mass quality data from north ramp boreholes compares well with rock mass quality data from scan line observations in the tunnel**

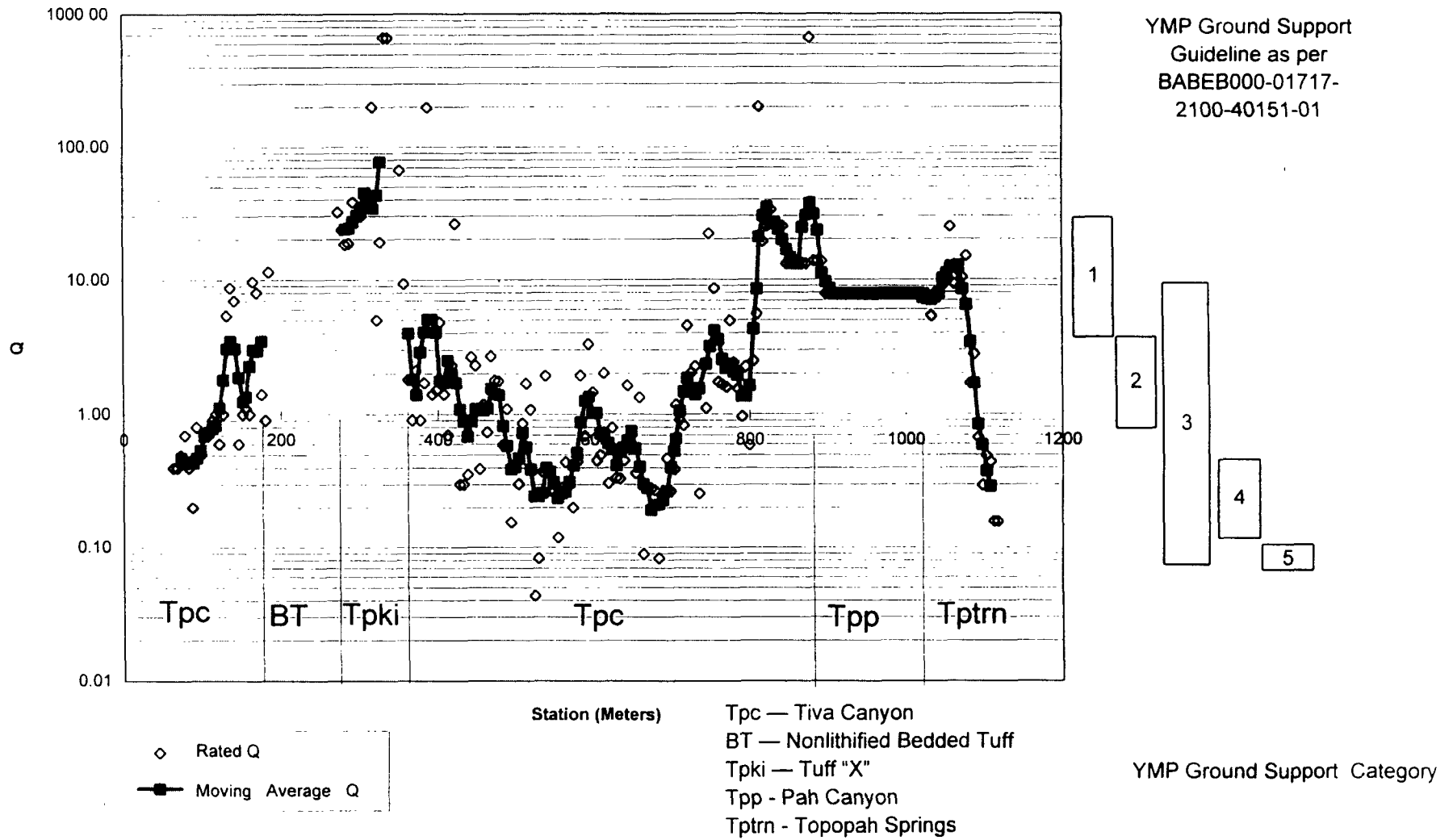
Comparison of Rock Mass Quality - Q NRG Borehole versus North Ramp Scanline Data Tiva Canyon Tuff

YMP Ground Support Guideline

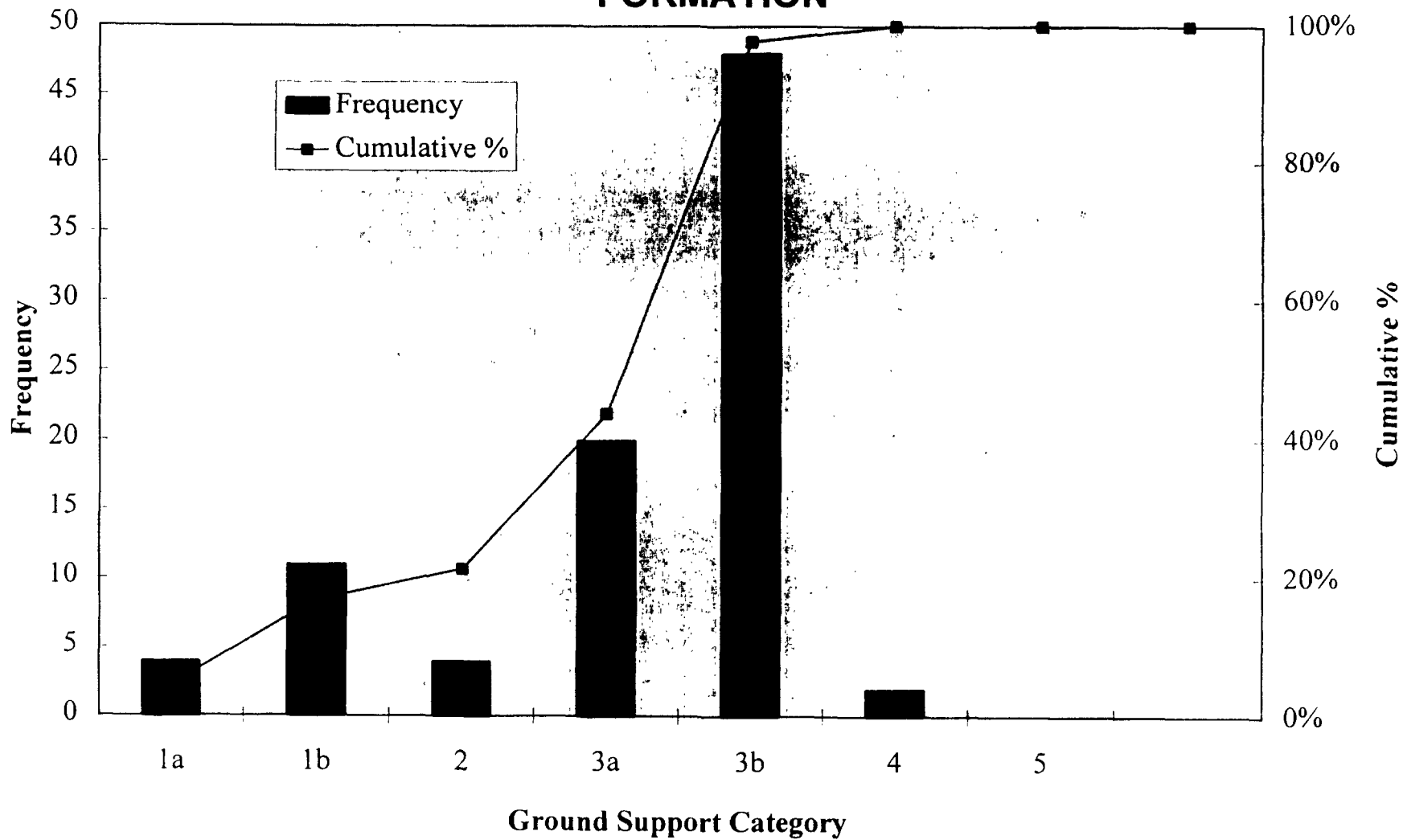
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COMPARISON OF MOVING AVERAGE AND RATED Q VALUES IN THE NORTH RAMP

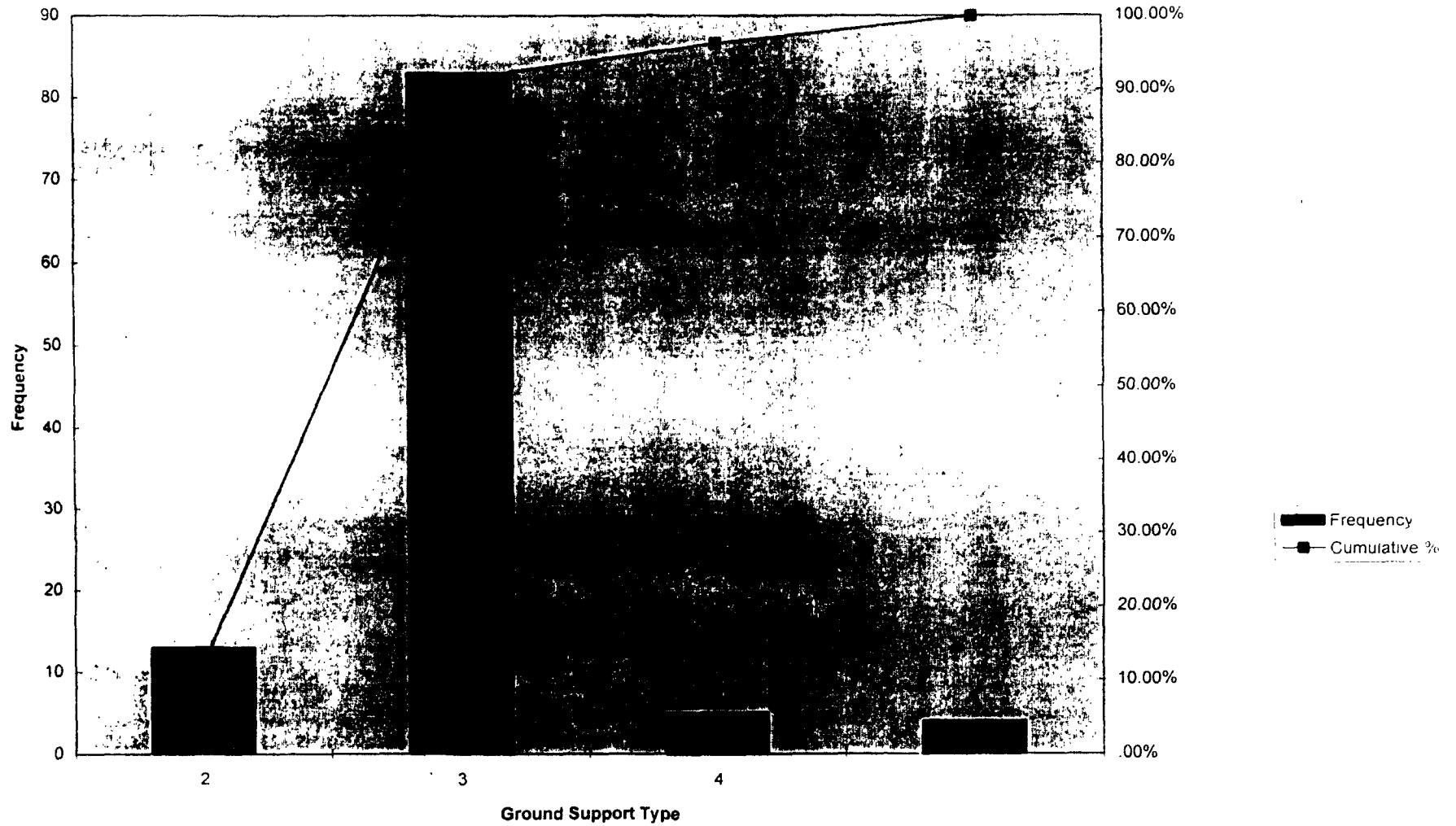


DISTRIBUTION OF GROUND SUPPORT CATEGORY FROM NRG BOREHOLE DATA FOR THE T_{pc} STRATIGRAPHIC UNIT OF THE TIVA CANYON FORMATION



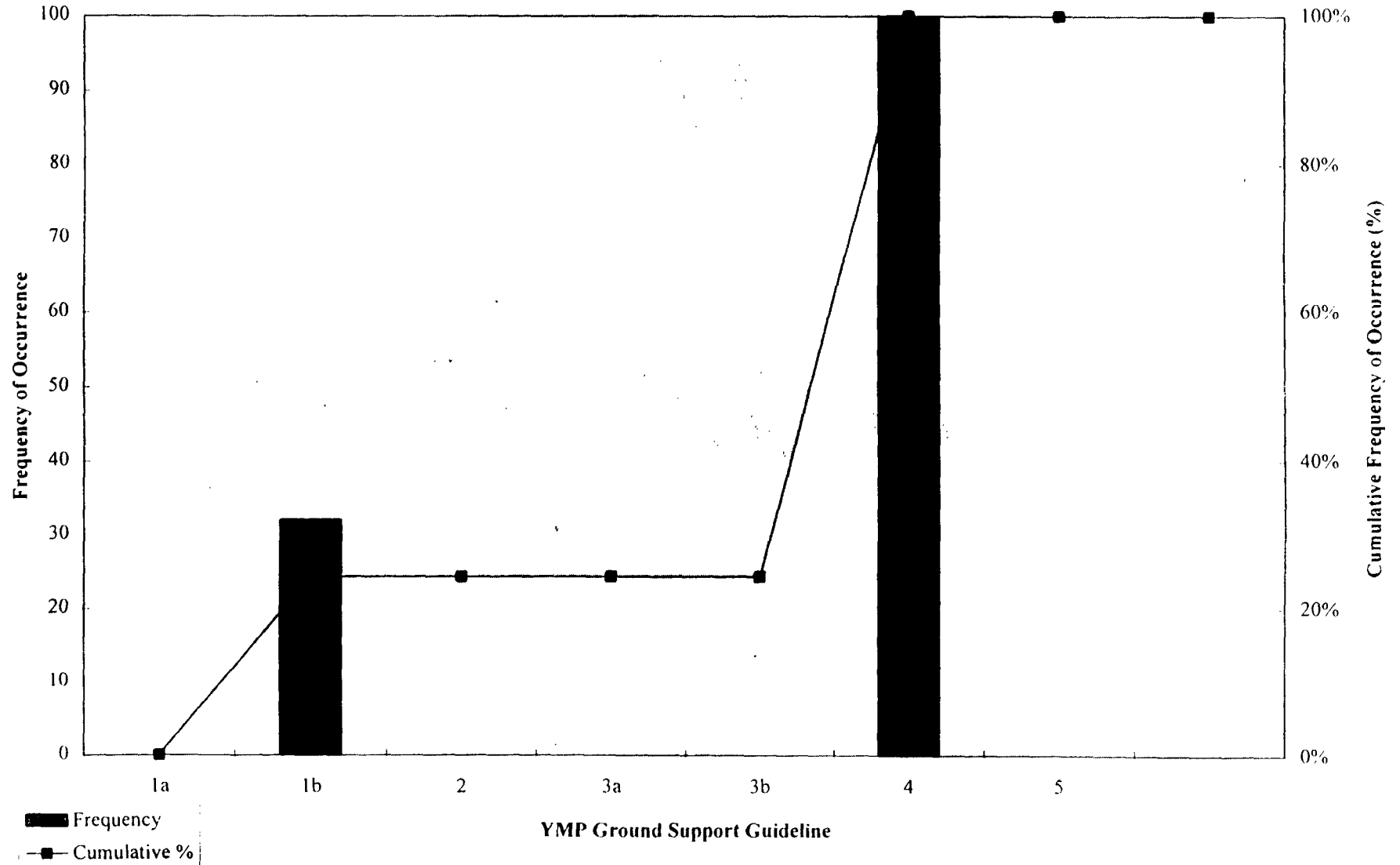
Distribution of YMP Ground
Support Guideline based on Scanline Q - TCw unit

FOR [unclear] [unclear]



Tpc Ground Support Chart 33

**Tpc - Installed Ground Support
Tunnel Stations 0+60 to 1+88, 3+50 to 8+80 (m)**



T.B.M. Rock Quality Estimate

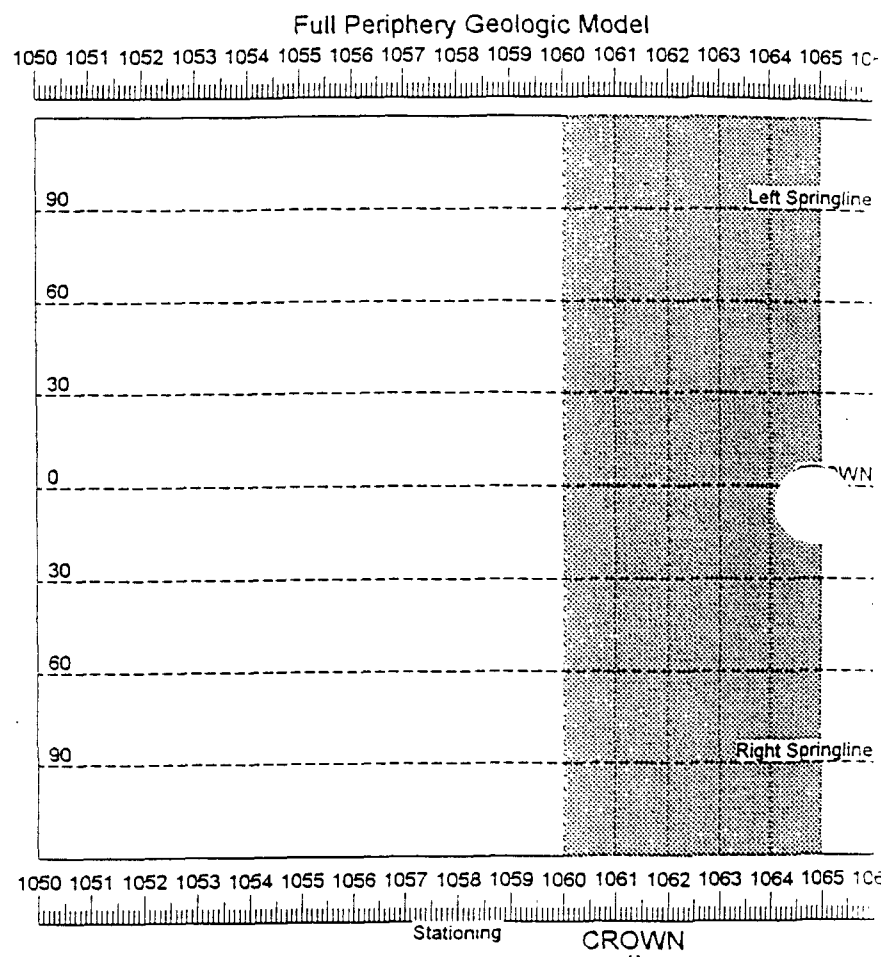
Start Station: 1060 End Station: 1065 Engineer: Ken Donnelson Date: 06/20/95
 Thermo-Mechanical Unit: TsW1 Stratigraphic Unit: Tptrn: Topopah Spring crystal rich nonlithophysal, vitric
 Ground Support: Category 1. Ground Support
 Checked By: CAS Date: 6/21/95 Field Checked By: _____ Date: _____
 Important Geology: Brick rd omg on Lf & lt bm on Rt. 0.5 deep x 1 x 2 ovrbrk.
 Comment: 0.28M past Pan 294 to Pan 301. Ovrbrk @ "2:00".

Q Factors

RQD	<u>91.3</u>
Joint Set #	<u>3.0</u>
Joint Roughness #	<u>3.8</u>
Joint Alteration #	<u>5.0</u>
Water Reduction Factor	<u>1.0</u>
Stress Reduction Factor	<u>2.5</u>
Q	9.3
Rock Quality	Fair

RMR Factors

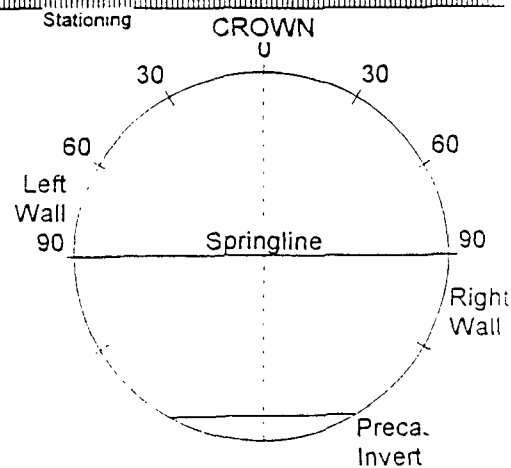
RQD (average)	<u>20.0</u>
Intact Rock Strength	<u>4.0</u>
Joint Spacing	<u>20.0</u>
Joint Condition	<u>10.9</u>
Ground Water	<u>15.0</u>
Joint Orientation Adjust.	<u>-5.0</u>
RMR Index	65.0
Rock Quality	Good
RQD/Jn	<u>30.4</u>
Jr/Ja	<u>0.8</u>



YMP Ground Support Guideline
 Category 1 ground support (refer to drawing 40152)
 Rockbolts & 3" x 3" WWF.
 Supplement with spot bolting up to category 2 bolt density.

Support Measures *

Cat	Q	RQD/Jn	Jr/Ja	Support type	Note
17	10-4	>30	-	sb (utg)	
		>=10, <=30	-	B (utg) 1-5 m	
		>10	-	B (utg) 1-5 m	
				+S 2-3 cm	



* Barton et al. (1974)
 File: C:\TBM\TBM1
 Code: TBM.EXE Ver: 1.0. Agapito Associates, Inc.

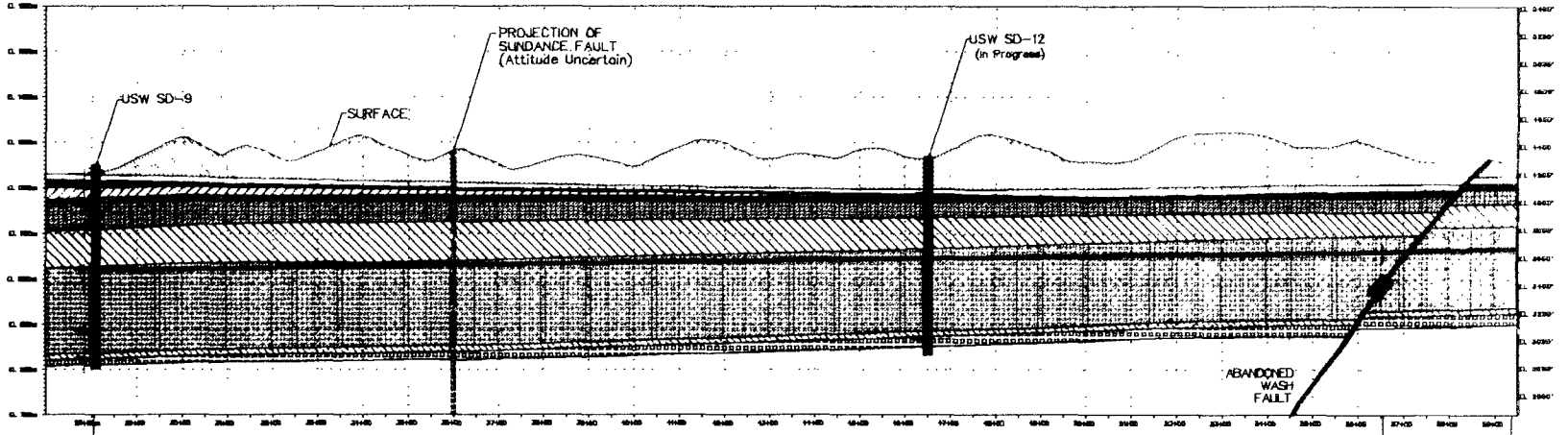
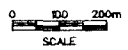
Conclusions

- **Faults**
- **Stratigraphy**
- **Fractures**
- **Rock Quality**

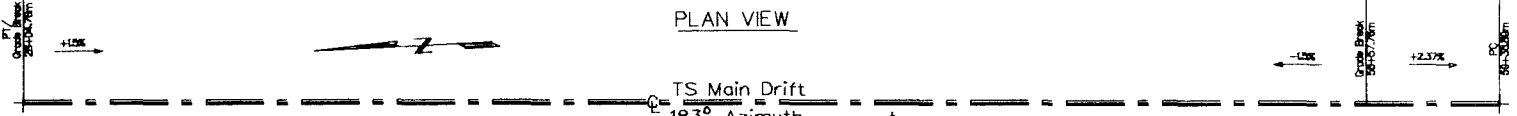


**Substantially
as
predicted**

SECTION VIEW



PLAN VIEW



STRATIGRAPHY¹

LITHO-STRATIGRAPHIC UNITS	SYMBOL	THERMAL-MECHANICAL UNITS
TIVA CANYON	[Symbol]	Tpcun
[Symbol]	[Symbol]	Tpcpvf & 2
[Symbol]	[Symbol]	Tpb4
YUCCA Mtn	[Symbol]	Tpy
[Symbol]	[Symbol]	Tpb3
PAH CANYON	[Symbol]	Tpp
[Symbol]	[Symbol]	Tpb2
PANTERUSH GROUP	[Symbol]	Tplv2 & 3
[Symbol]	[Symbol]	Tptrn
[Symbol]	[Symbol]	Tp4t
[Symbol]	[Symbol]	Tp4tm
[Symbol]	[Symbol]	Tp4p
[Symbol]	[Symbol]	Tp4pn
[Symbol]	[Symbol]	Tp4w3
[Symbol]	[Symbol]	Tp4w2
[Symbol]	[Symbol]	Qn

LEGEND

PROPOSED TS MAIN DRIFT ALIGNMENT

DRILLHOLE CONTACTS BASED ON PROJECTING BOREHOLE ALONG DF

PRELIMINARY TS MAIN DRIFT DATA QA:N

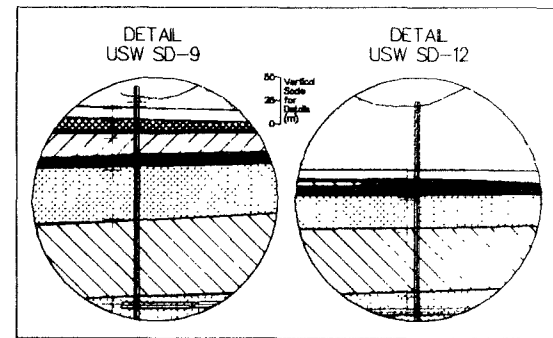
Station (m)	Grade	Strike	Dip	Station	Elevation (m)
28+04.78 (PT)	+1.85	234.085.7	172.15.8	28+04.78	2086.66
28+04.78 (PC)	+2.378	233.953.6	173.84.7	28+04.78	1987.74
28+04.78 (PC)	+2.378	233.953.6	173.84.7	28+04.78	1134.41

BOREHOLE PROJECTIONS QA:L

Borehole	Projection	Qty	Distance to Surface (m)
USW SD-9	2°	2.6°	74.1
USW SD-12	2°	2.6°	68.2

BOREHOLE CONTACT PROJECTIONS QA:N

Borehole	Projection	Qty	Distance to Surface (m)
USW SD-9	2°	2.6°	74.1
USW SD-12	2°	2.6°	68.2



¹ Stratigraphic and thermal-mechanical units as defined by Blasech et al., USGS Open File Report 04-149, in cross, "Revised Stratigraphic nomenclature and macroscopic interpretation of lithostratigraphic units of the Panterush Group exposed at Yucca Mountain, Nevada."

Note: Stratigraphic contacts based on LEIS LYNX Mode VMPL12. Not qualified data. Projections of stratigraphic contacts from USW SD-9 and USW SD-12. Qualified data.

TS MAIN DRIFT CHARACTERIZATION SITE: YUCCA MOUNTAIN PROJECT CROSS SECTION ALONG DRIFT FROM 28+04.78m (PT) to 59+36.89 (PC)

Sandia National Laboratories

BASE DRAWING: LEIS LYNX MODE VMPL12
 DATE: 09/15/04
 BY: JMM
 VERSION: 1.0
 SUPERSEDES: NONE

DESIGNED BY: CEB/CEM
 FILE SCALE: AS SHOWN
 DATE: 09/15/04
 SHEET: 1 OF 1

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 FILE NO.: 04-333-01
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