

Summary of Bechtel Seismic Sources



Source	Description	Distance ¹ (mi)	(km)	Pa ²	Mmax (Mb) ³ and Wts. ³
<i>Sources within 200 mi (320 km)</i>					
BZ1	Gulf Coast Region Background	0	0	1.0	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]
BZ3	Northern Plains Region Background	30	48	1.0	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]
38	Ouachita	70	113	0.25	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]
BZ0	New Madrid Region Background	140	225	1.0	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]
31	Reelfoot Rift	190	306	0.60	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]
<i>Selected sources beyond 200 mi (320 km)</i>					
30	New Madrid Fault Zone	235	378	1.00	7.4 [0.10] 7.5 [0.90]

1 Closest distance between site and source measured from Bechtel seismic source map (Reference 9)
 2 Pa = probability of activity; from Reference 10
 3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

SERI
 GRAND GULF NUCLEAR STATION SITE
 EARLY SITE PERMIT APPLICATION
 SITE SAFETY ANALYSIS REPORT

EPRI SOG
 SEISMIC SOURCE ZONES
 BECHTEL TEAM



Summary of Dames & Moore Seismic Sources

Source	Description	Distance ¹ (mi)	(km)	Pa ²	Mmax (Mb) and Wts. ³
Sources within 200 mi (320 km)					
20	Southern Coastal Margin	0	0	1.0	5.3 [0.80] 7.2 [0.20]
25	Ouachitas Fold Belt	60	97	0.35	5.5 [0.80] 7.2 [0.20]
71	Indiana-Illinois Block	165	266	1.0	5.7 [0.80] 7.2 [0.20]
22	Reelfoot Rift	165	266	1.0+	6.9 [0.75] 7.2 [0.25]
C15	Combined 21 & 22	165	266	N.A.	6.9 [0.75] 7.2 [0.25]
4	Appalachian Fold Belt	170	274	0.35	6.0 [0.80] 7.2 [0.20]
8	Eastern Marginal Basin	175	282	0.08	5.6 [0.80] 7.2 [0.20]
Selected sources beyond 200 mi (320 km)					
21	New Madrid Compression Zone	250	403	1.0	7.2 [0.25] 7.5 [0.75]

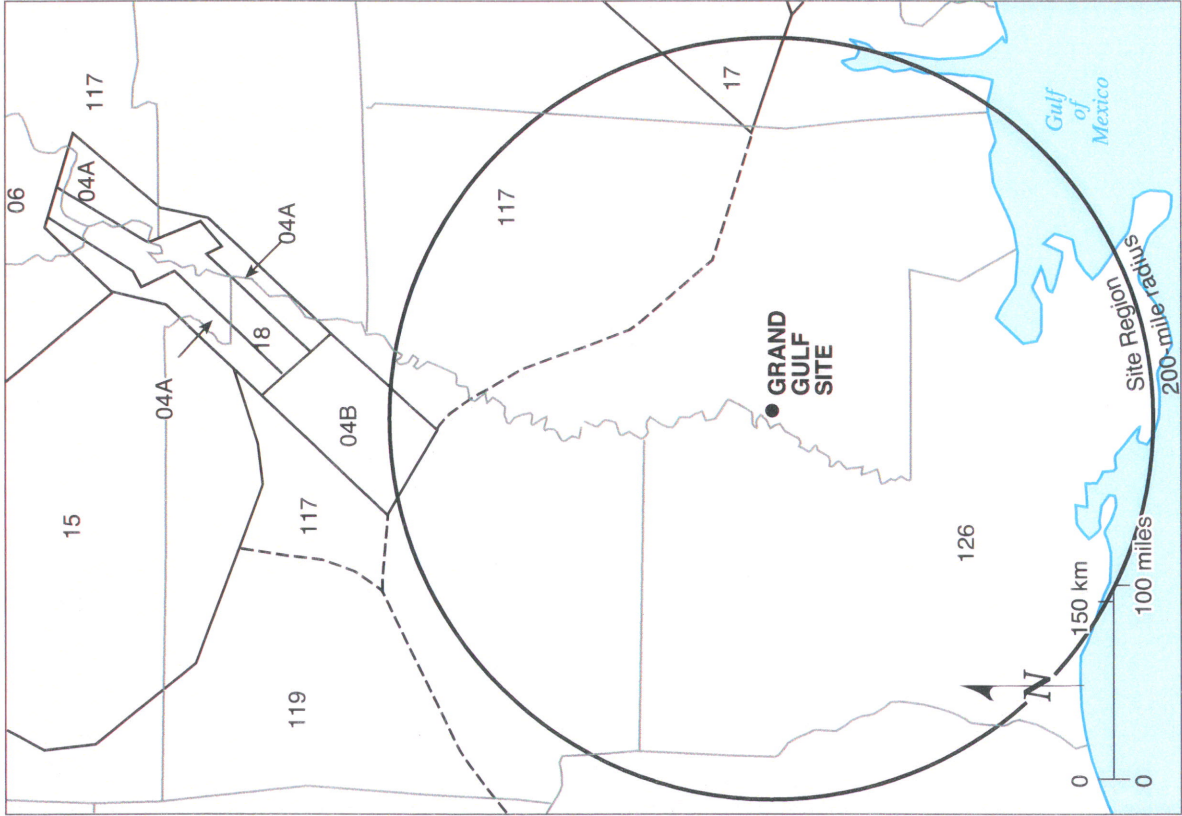
1 Closest distance between site and source measured from Dames & Moore seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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Summary of Law Engineering Seismic Sources

Source	Description	Distance ¹ (mi)	(km)	Pa ²	Mmax (Mb) and Wts. ³
<i>Sources within 200 mi (320 km)</i>					
126	Southern Coastal Block	0	0	1.00	4.6 [0.90] 4.9 [0.10]
117	Mississippi Embayment	80	128.8245	1.00	5.2 [0.50] 5.7 [0.50]
17	Eastern Basement	140	225.4428	0.62	5.7 [0.20] 6.8 [0.80]
04A	Reelfoot Rift	170	273.752	0.90	6.2 [0.50] 6.8 [0.50]
<i>Selected sources beyond 200 mi (320 km)</i>					
04B	Reelfoot Rift Alternative	225	362.3188	0.10	6.2 [0.50] 6.8 [0.50]
18	Postulated Faults in Reelfoot Rift	230	370.3704	1.00	7.4 [1.00]

1 Closest distance between site and source measured from Law Engineering seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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Summary of Rondout Seismic Sources

Source	Description	Distance ¹ (mi)	(km)	Pa ²	Mmax (Mb) and Wts. ³
<i>Sources within 200 mi (320 km)</i>					
51	Gulf Coast/Bahamas	0	0	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20] 5.8 [0.15] 6.5 [0.60] 6.8 [0.25]
16	Southern Oklahoma Aulacogen/Ouachita	100	161.0306	1.00	
52	Pre-Grenville Precambrian Craton	110	177.1337	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]
50	Grenville Crust	125	201.2882	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]
2	New Madrid Rift Complex (Reelfoot Rift)	170	273.752	1.00	6.6 [0.30] 6.8 [0.60] 7.0 [0.10]
13	Southern New York-Alabama Lineament	180	289.8551	1.00	5.2 [0.30] 6.3 [0.55] 6.5 [0.15]
<i>Selected sources beyond 200 mi (320 km)</i>					
1	New Madrid Seismic Zone	255	410.628	1.00	7.1 [0.10] 7.3 [0.80] 7.4 [0.10]

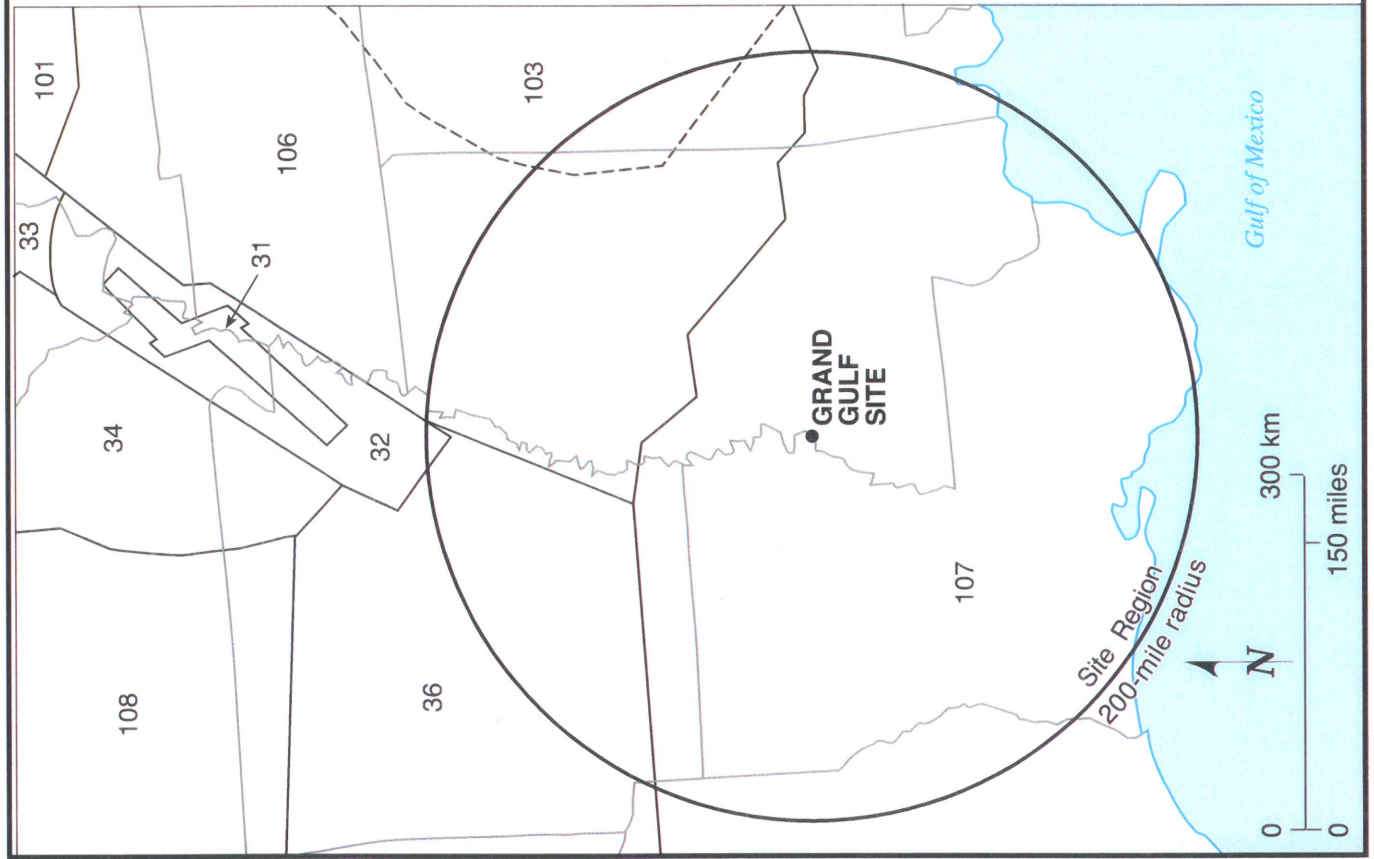
1 Closest Distance between site and source measured from Rondout seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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RONDOUT ASSOCIATES TEAM



Summary of Weston Seismic Sources

Source	Description	Distance ¹ (mi)	(km)	Pa ²	Mmax (Mb) and Wts. ³
<i>Sources within 200 mi (320 km)</i>					
107	Gulf Coast Background	0	0	1.00	5.4 [0.71] 6.0 [0.29]
106	South Central Background	60	97	1.00	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]
36	Ancestral Rockies Source	100	161.0306	1.00	5.4 [0.43] 6.0 [0.41] 6.6 [0.16]
103	Background dSouthern Appalachian	160	257.649	1.00	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]
32	Reelfoot Rift	185	297.9066	1.00	7.2 [1.00]
C-11	Combined 32 & 31	185	297.9066	N.A.	6.0 [0.13] 6.6 [0.77] 7.2 [0.10]
<i>Selected sources beyond 200 mi (320 km)</i>					
31	New Madrid Fault Zone	235	378.4219	0.95	7.2 [1.00]
34	Saint Louis Arm NMRC	240	386.4734	1.00	5.4 [0.23] 6.0 [0.52] 6.6 [0.21] 7.2 [0.04]

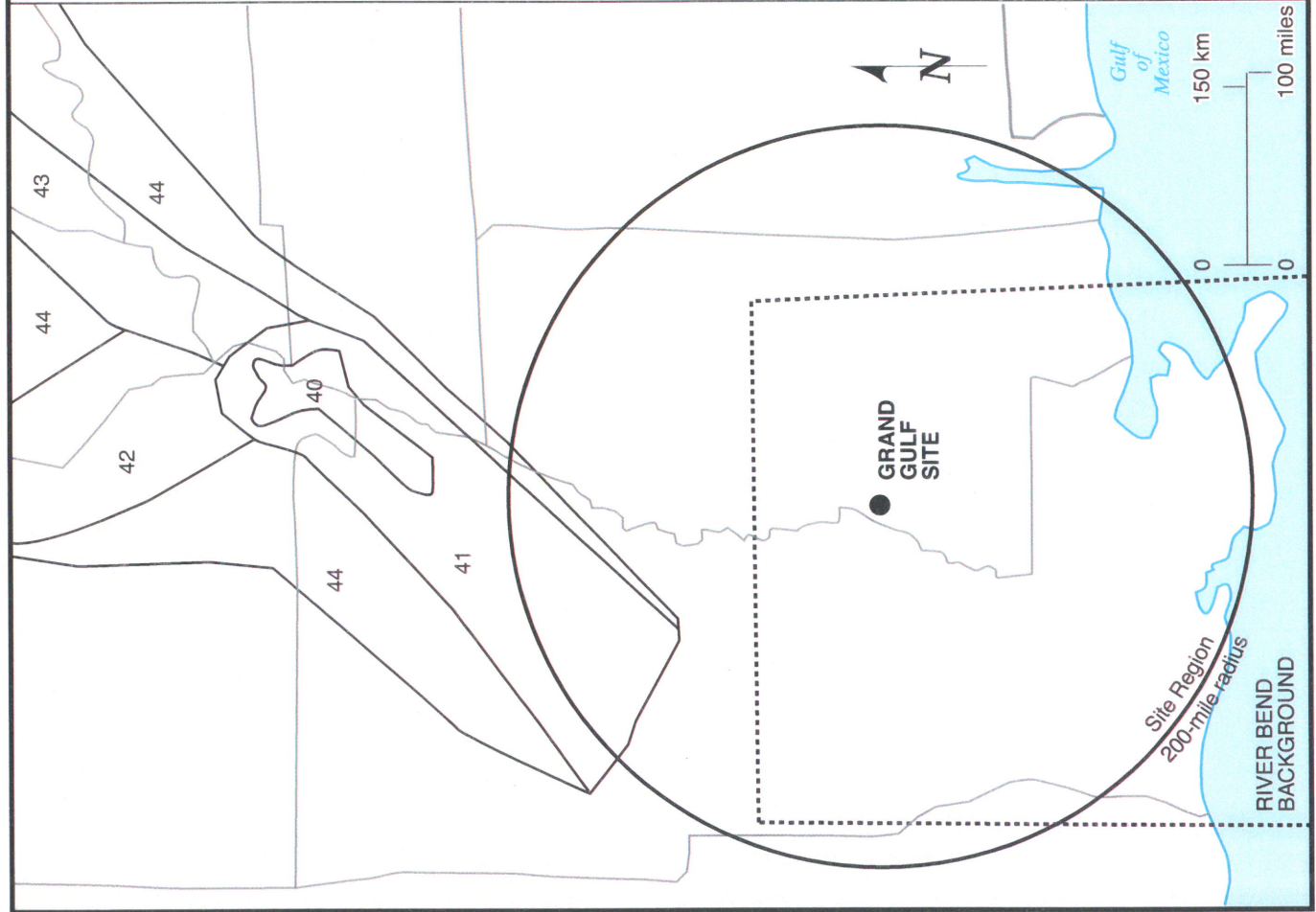
1 Closest distance between site and source measured from Weston Geophysical seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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WESTON GEOPHYSICAL CORPORATION TEAM



Summary of Woodward-Clyde Seismic Sources

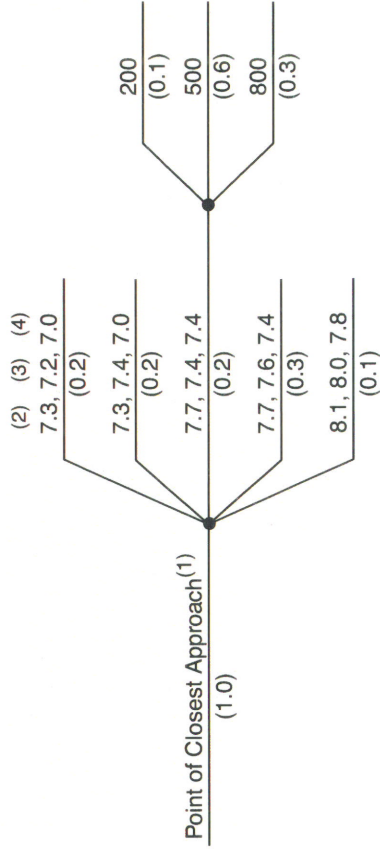
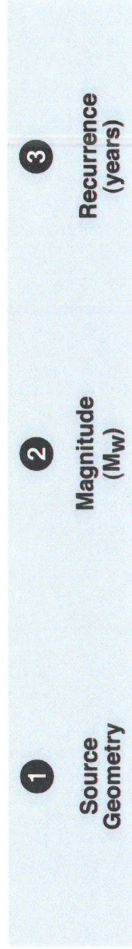
Source	Description	Distance ¹ (mi)	(km)	Pa ²	Mmax (Mb) and Wts. ³
<i>Sources within 200 mi (320 km)</i>					
	River Bend Background	0	0	N.A.	5
41	Reelfoot Rift-New Madrid Rift Complex	130	210	1.00	5.4 [0.33] 6.8 [0.34] 7.2 [0.33]
44	New Madrid Rift Loading Volume	137	220	1.00	5.6 [0.33] 6.3 [0.34] 6.9 [0.33]
<i>Selected sources beyond 200 mi (320 km)</i>					
40	Disturbed Zone of Reelfoot Rift	224	360	1.00	7.2 [0.33] 7.5 [0.34] 7.9 [0.33]
43	Southern Indiana Arm and NOTA	311	500	1.00	5.8 [0.33] 6.3 [0.34] 7.4 [0.33]
42	Saint Louis Arm and NOTA	323	520	1.00	6.2 [0.33] 6.8 [0.34] 7.2 [0.33]

1 Closest Distance between site and source measured from Woodward Clyde Consultants seismic source map (Reference 9)
 2 Pa = probability of activity; from Reference 10
 3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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 WOODWARD CLYDE CONSULTANTS TEAM

FIGURE 2.5-44 REV. 1



(1) Point of closest approach refers to the point on each of the East Prairie, Reelfoot fault, Blythville Arch segments of the New Madrid Seismic Zone that is closest to the Grand Gulf site. See Figure CP-01-16 for segment and point of closest approach locations.

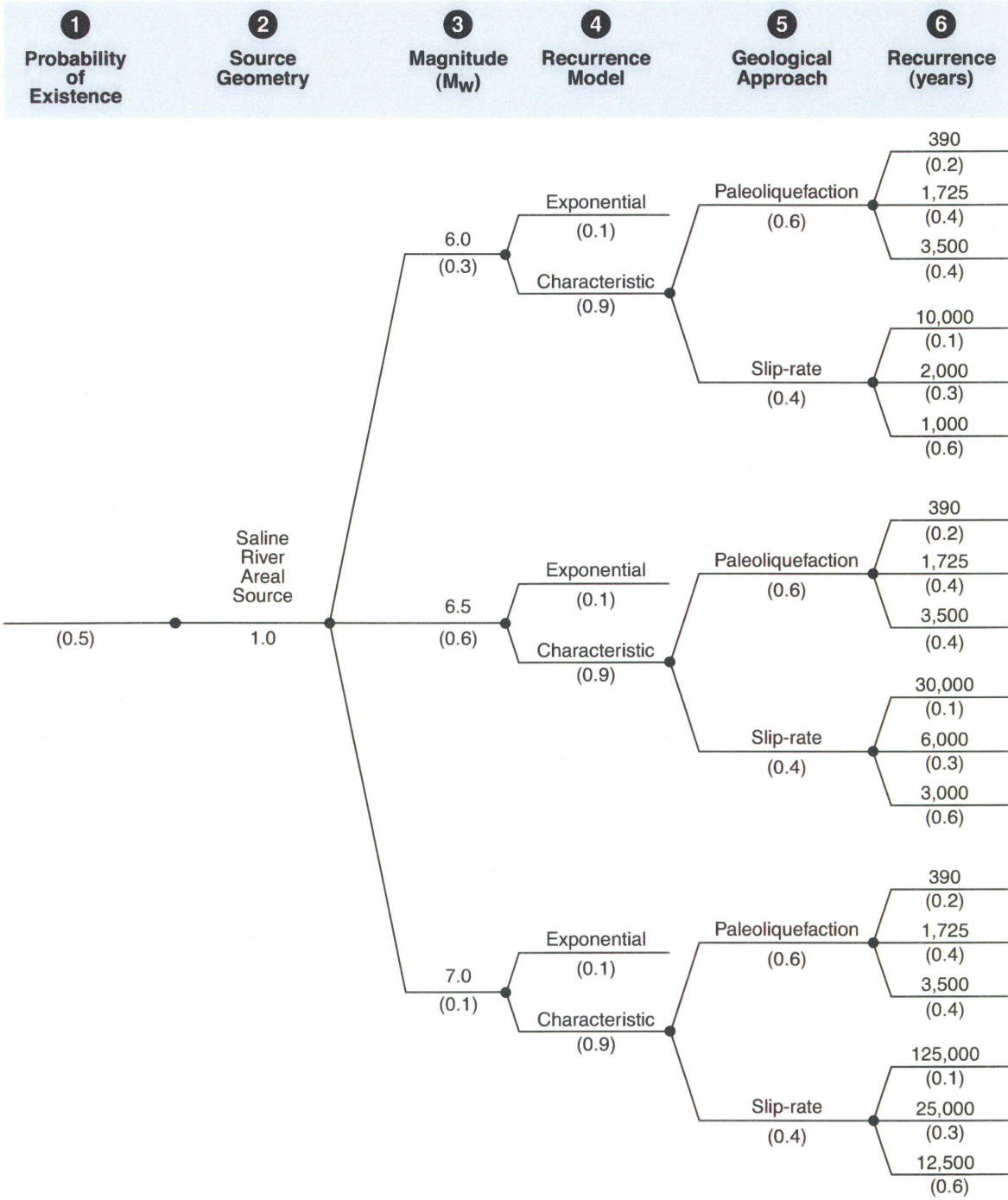
(2) Blythville Arch: weighted average = M_w 7.6

(3) Reelfoot Fault: weighted average = M_w 7.5

(4) East Prairie Fault: weighted average = M_w 7.3

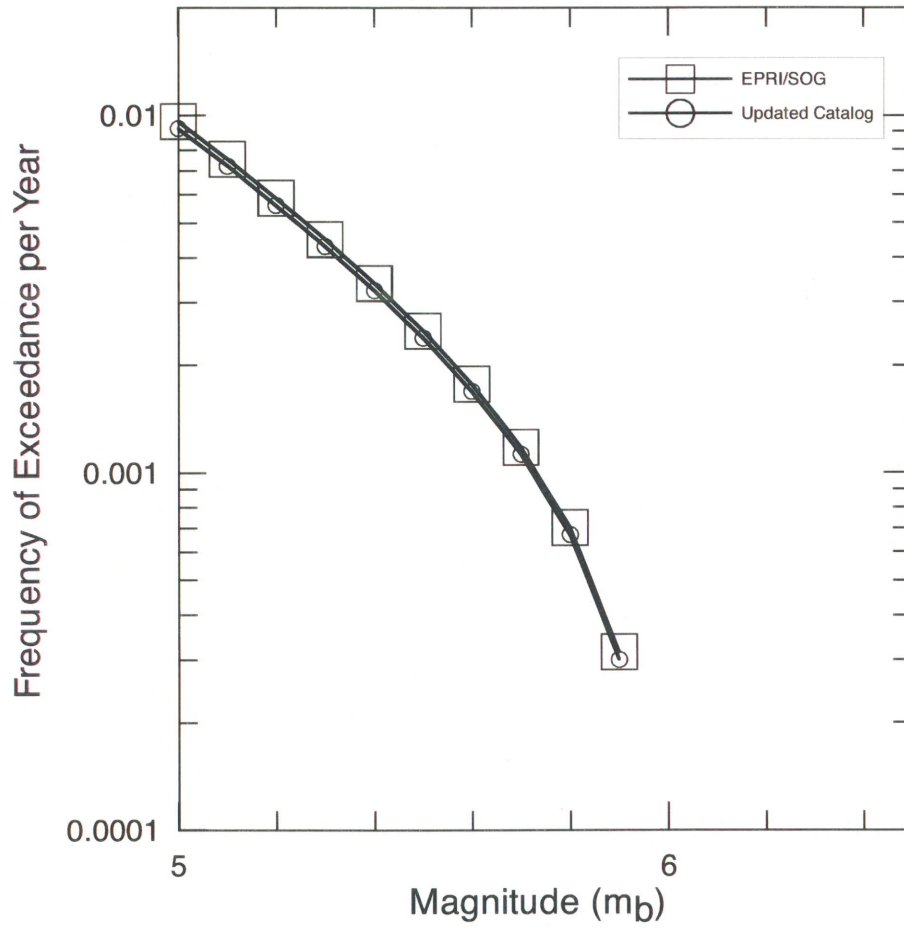
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LOGIC TREE
 FOR NEW MADRID SEISMIC ZONE



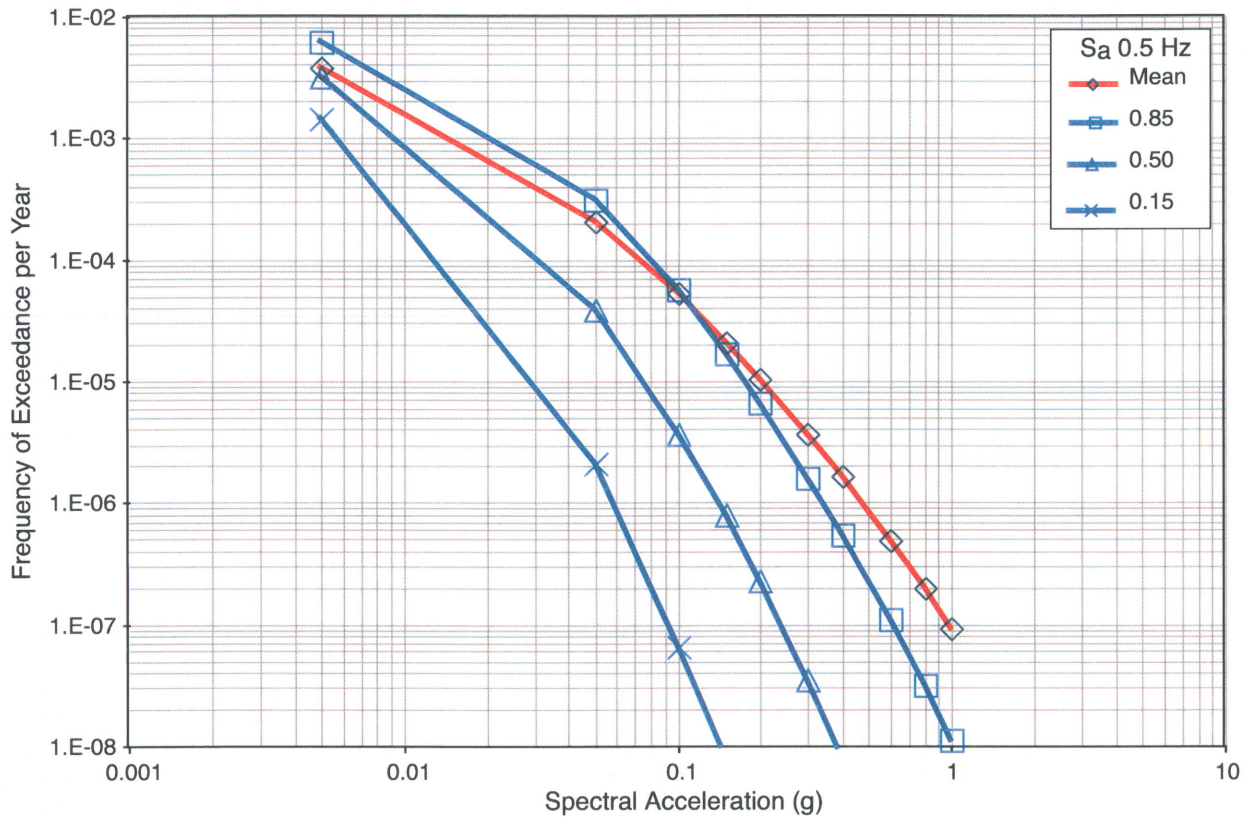
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LOGIC TREE
 FOR SALINE RIVER SOURCE ZONE



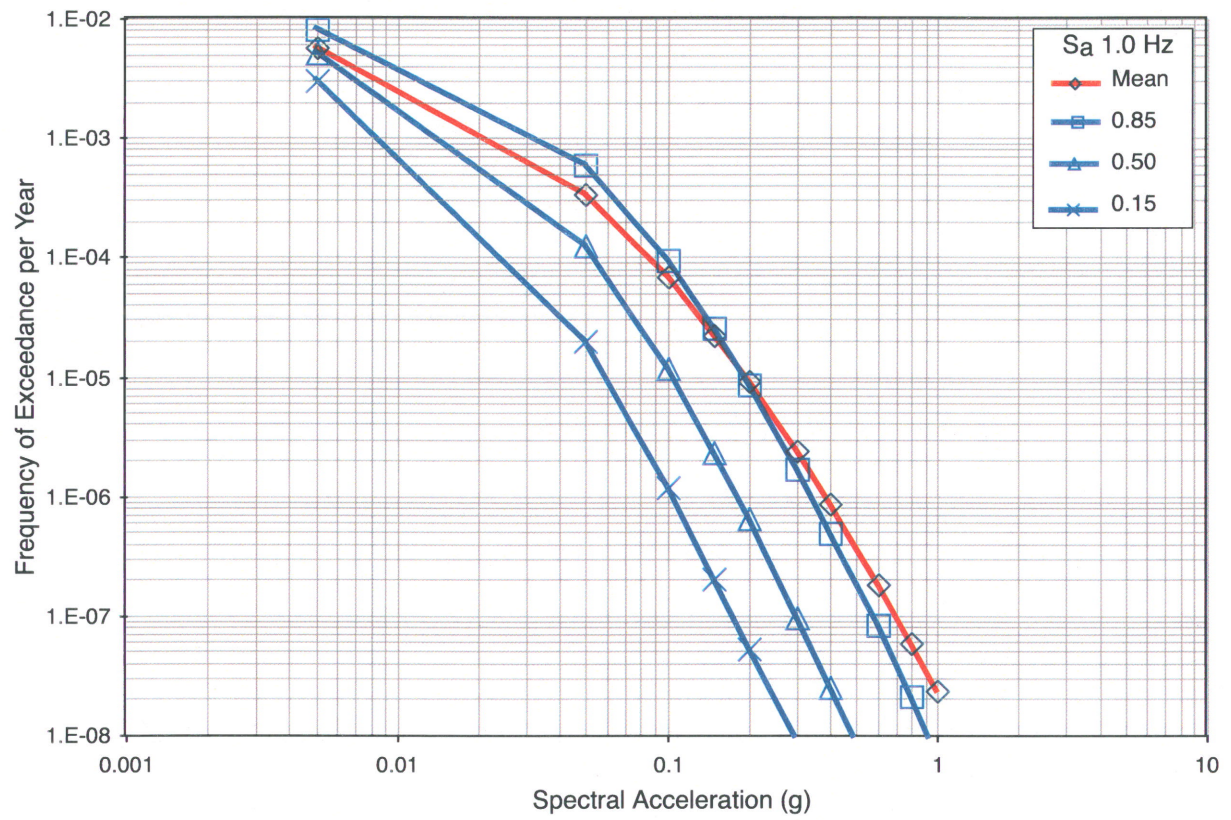
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COMPARISON OF THE SENSITIVITY OF
 ESTIMATES OF EARTHQUAKE
 OCCURRENCE RATES TO UPDATING THE
 EPRI EARTHQUAKE CATALOG TO 2001



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GGNS SEISMIC HAZARD RESULTS FOR
 Sa (0.5 Hz) FOR ROCK SITE CONDITIONS

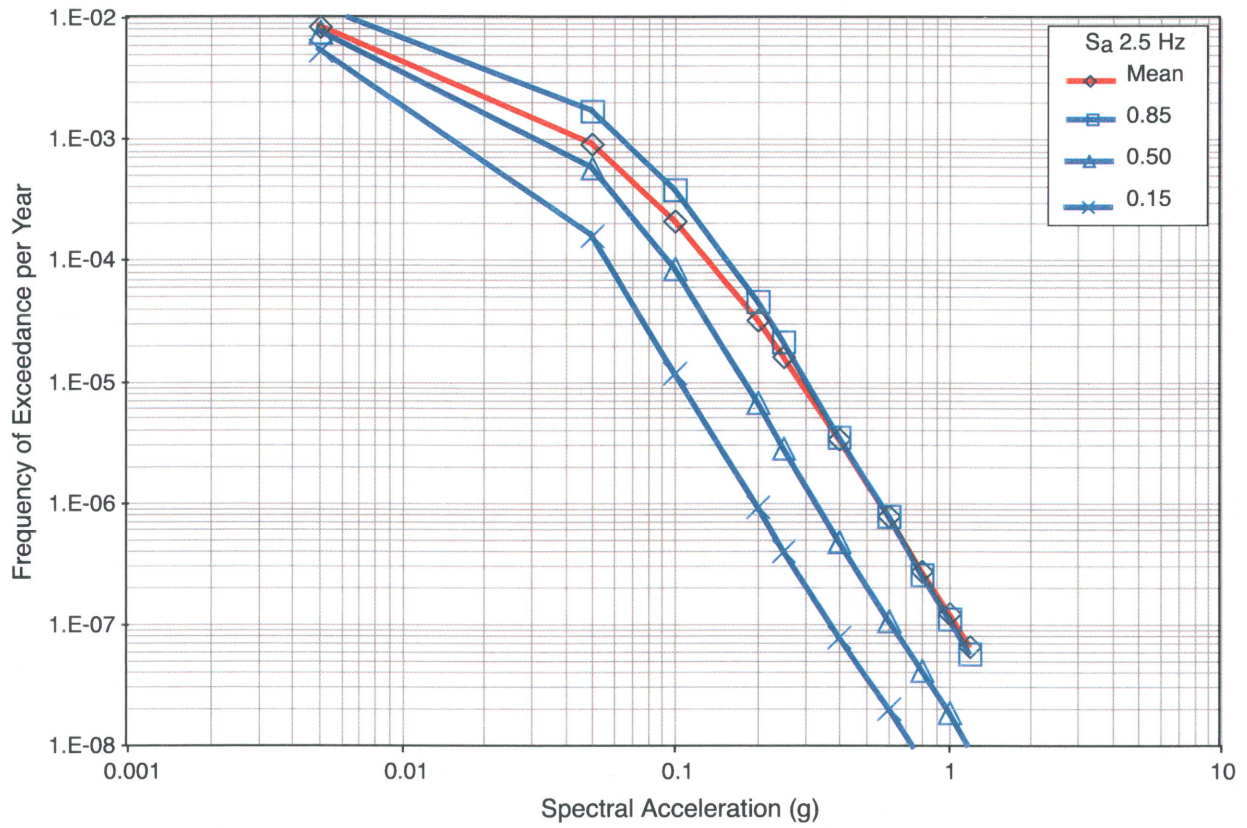


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GGNS SEISMIC HAZARD RESULTS FOR
 Sa (1 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-49

REV. 1

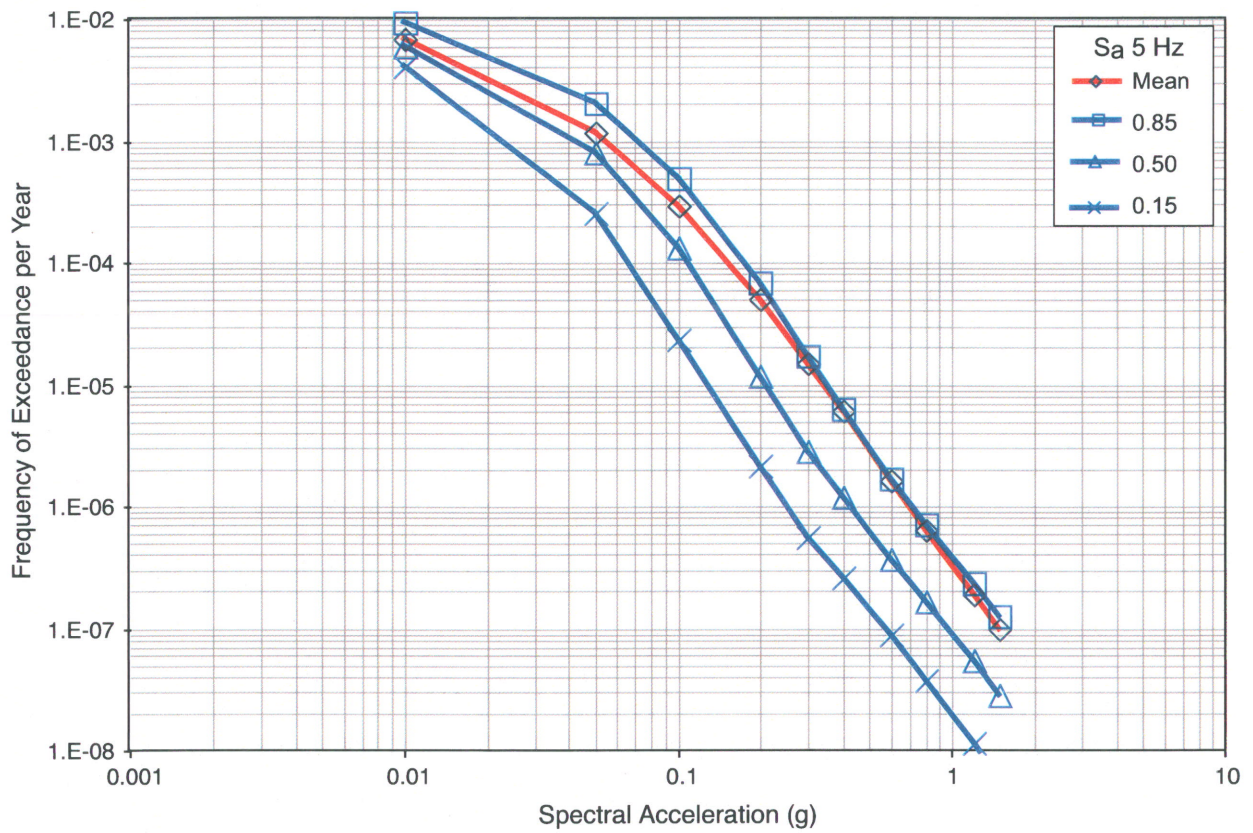


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GGNS SEISMIC HAZARD RESULTS FOR
 Sa (2.5 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-50

REV. 1

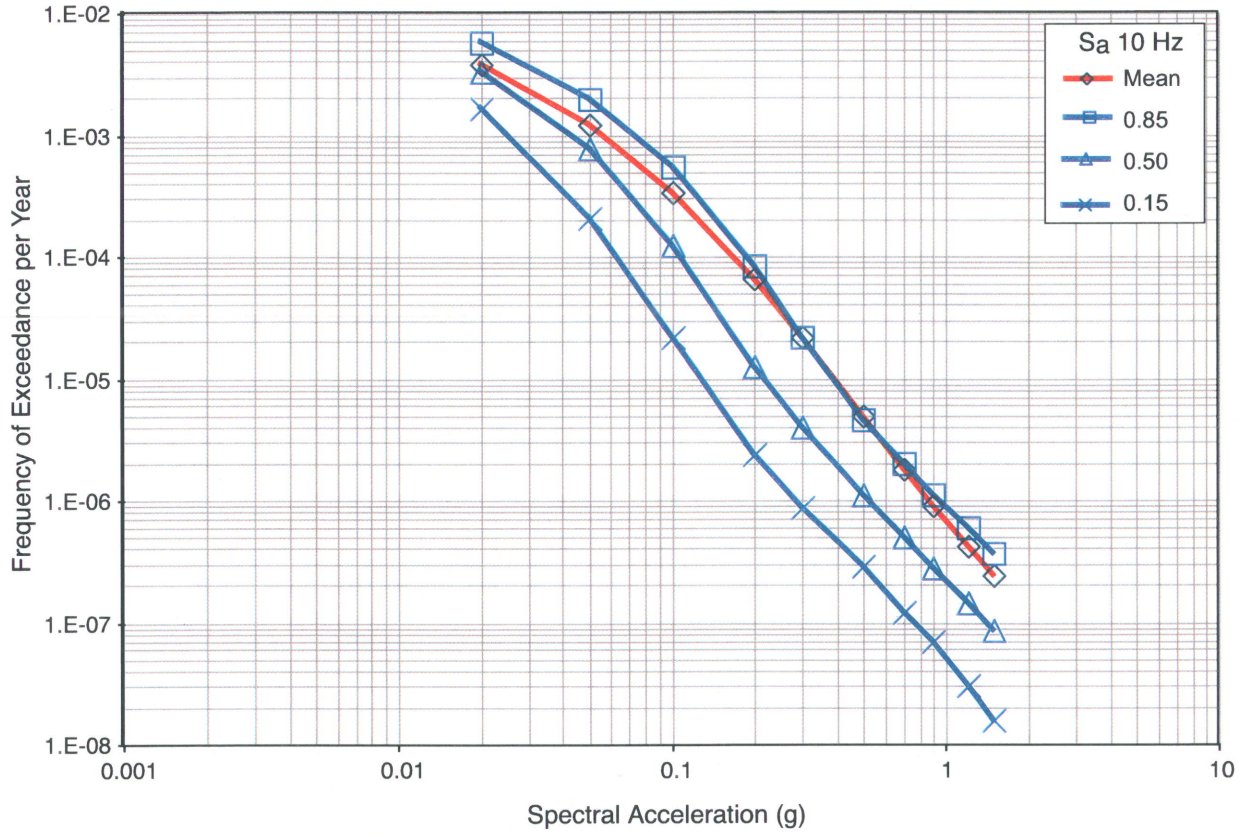


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GGNS SEISMIC HAZARD RESULTS FOR
 Sa (5 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-51

REV. 1

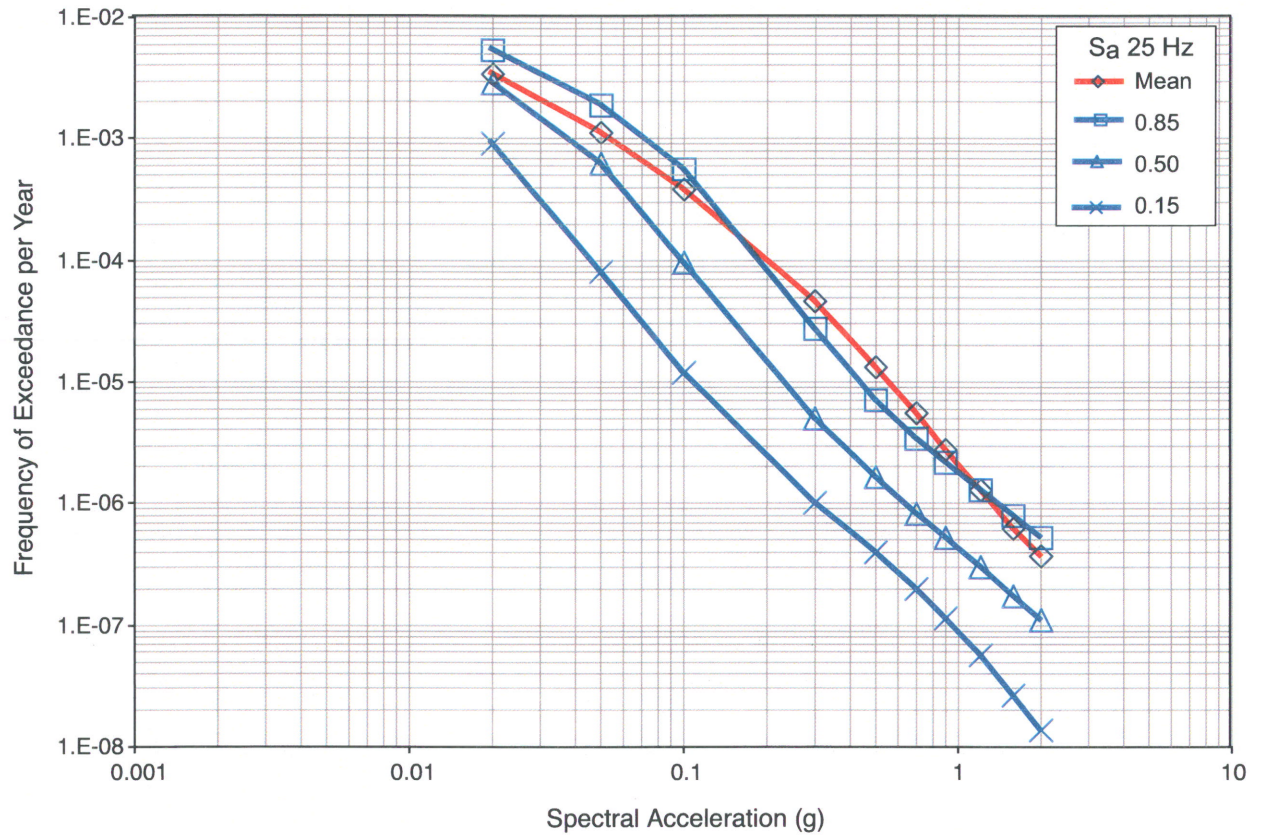


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GGNS SEISMIC HAZARD RESULTS FOR
 Sa (10 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-52

REV. 1

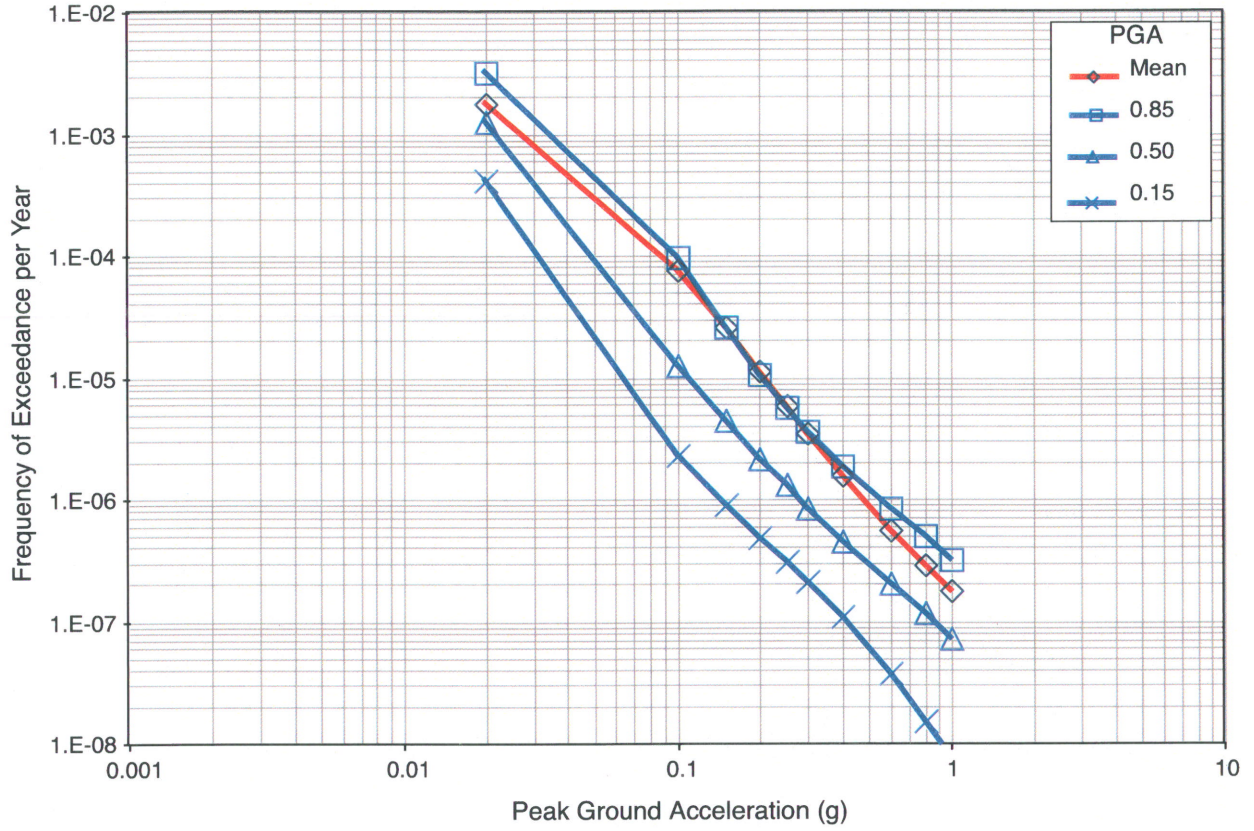


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GGNS SEISMIC HAZARD RESULTS FOR
 Sa (25 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-53

REV. 1

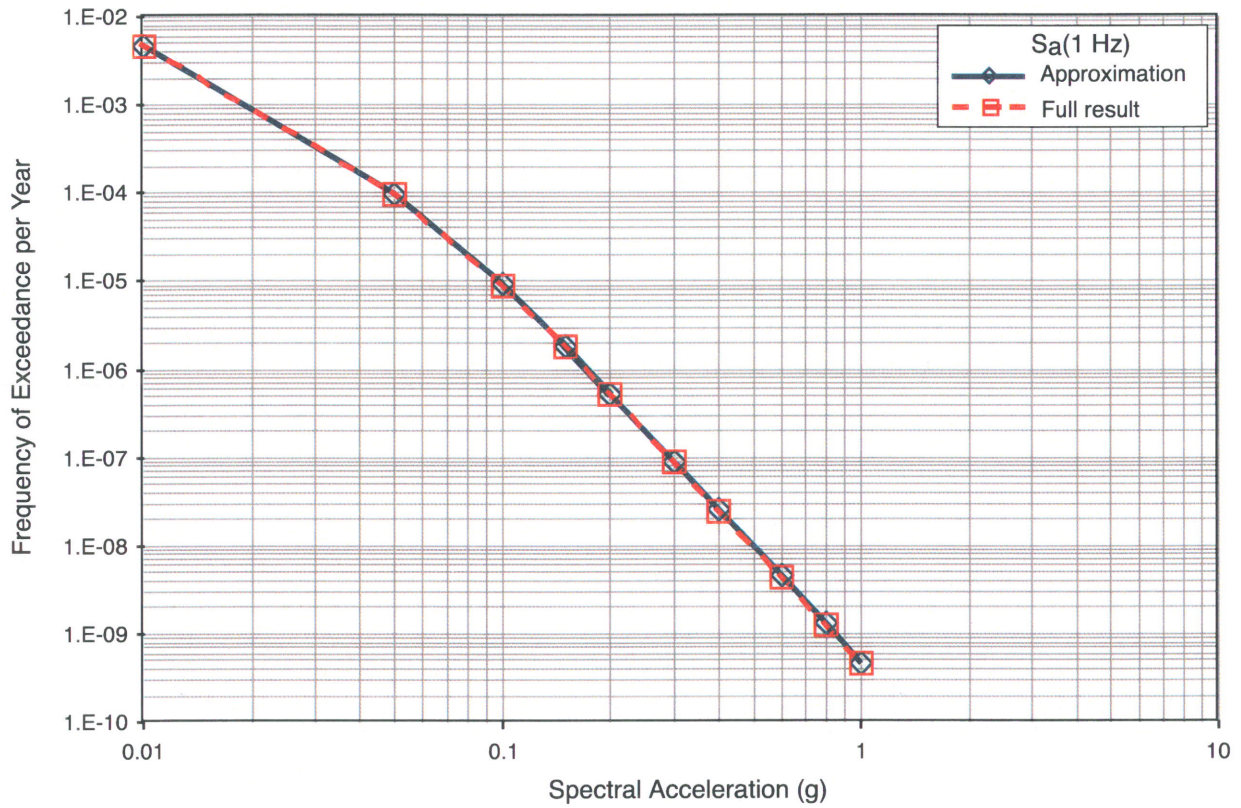


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GGNS SEISMIC HAZARD RESULTS FOR
 PGA FOR ROCK SITE CONDITIONS

FIGURE 2.5-54

REV. 1

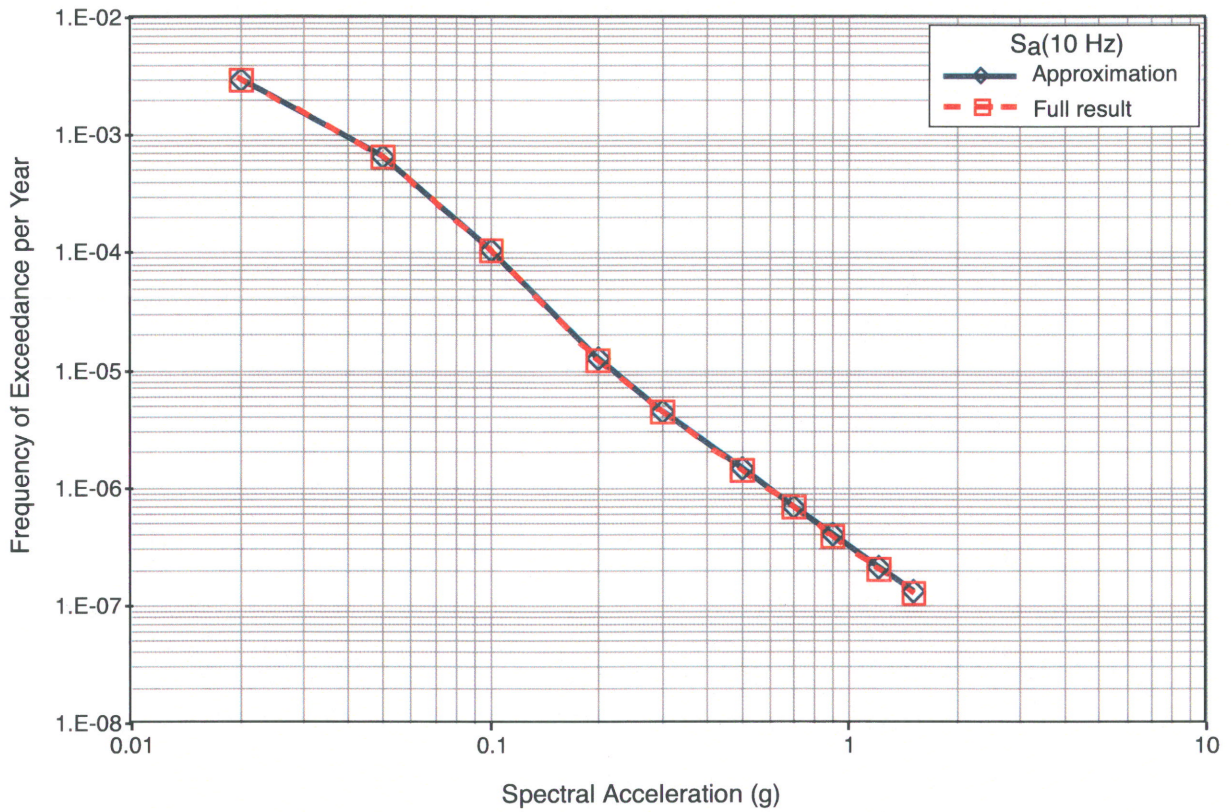


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ILLUSTRATION OF THE SENSITIVITY OF THE
 GGNS MEDIAN SEISMIC HAZARD RESULTS
 FOR Sa 1 Hz TO USING A REDUCED
 NUMBER OF SEISMICITY OPTIONS FOR THE
 ORIGINAL EPRI SOG SEISMIC SOURCES

FIGURE 2.5-55

REV. 1

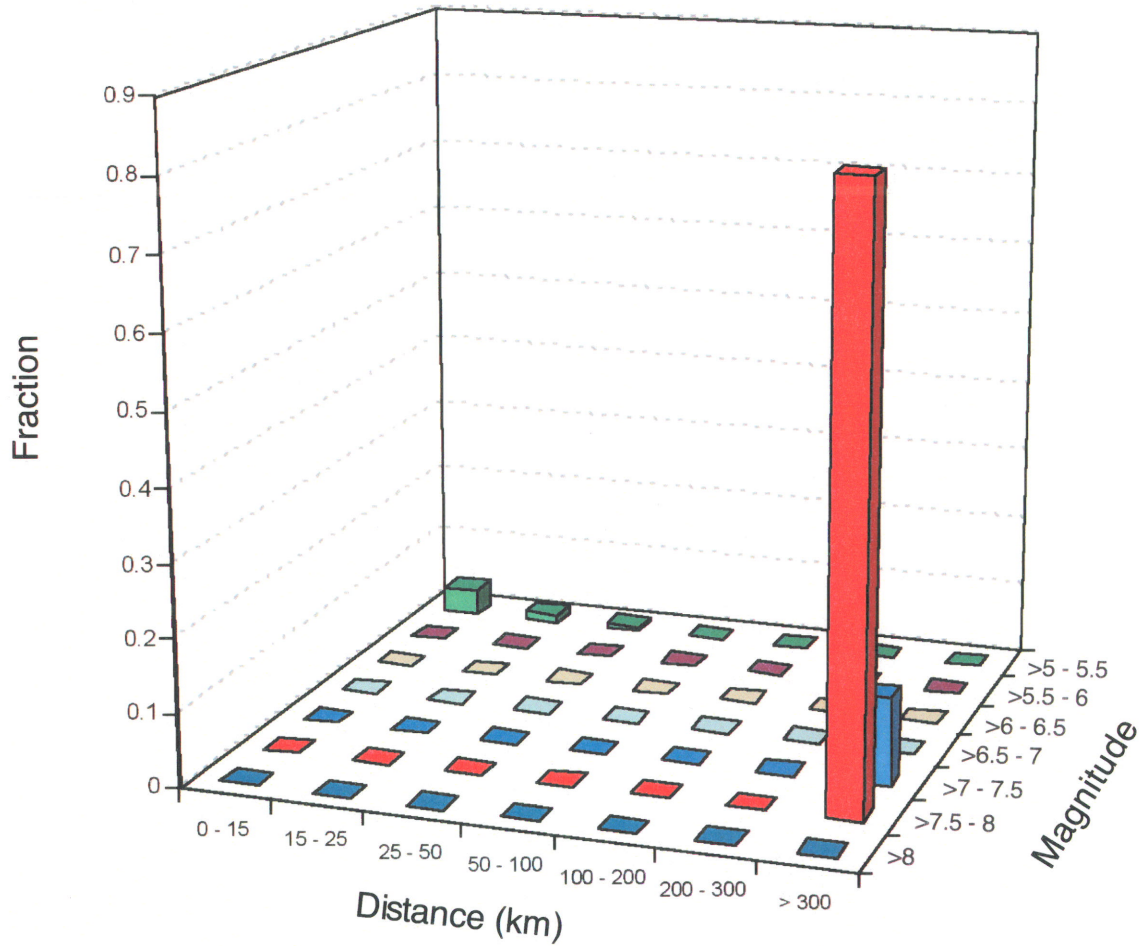


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ILLUSTRATION OF THE SENSITIVITY OF THE
 GGNS MEDIAN SEISMIC HAZARD RESULTS
 FOR S_a 10 Hz TO USING A REDUCED
 NUMBER OF SEISMICITY OPTIONS FOR THE
 ORIGINAL EPRI SOG SEISMIC SOURCES

FIGURE 2.5-56

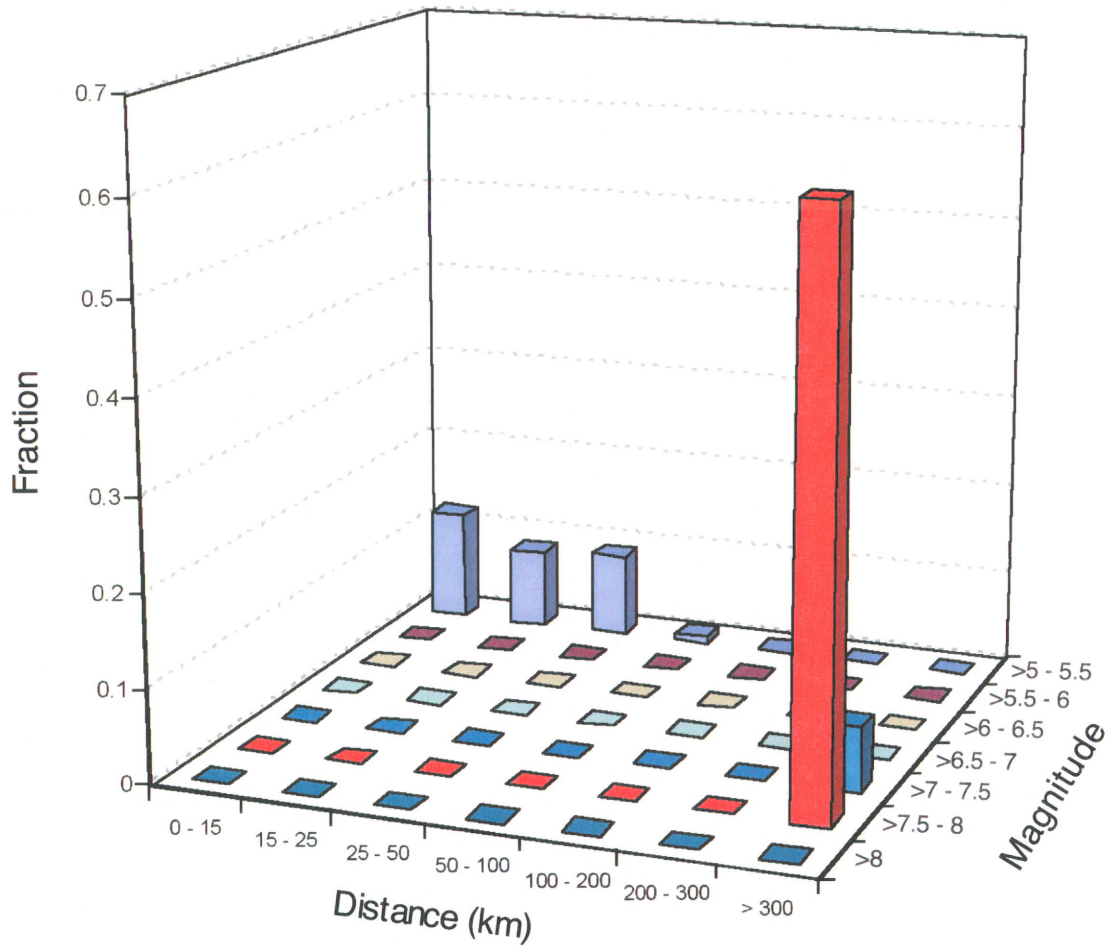
Low Frequency Deaggregation



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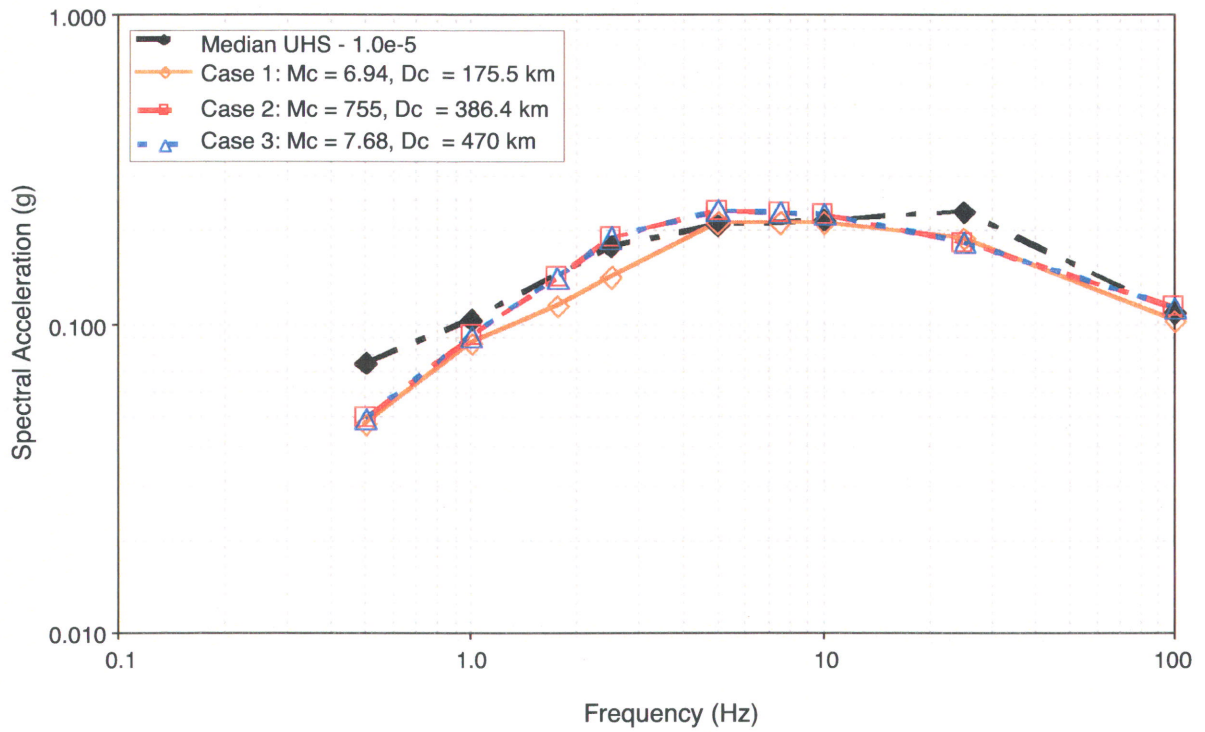
DEAGGREGATION FOR LOW
 FREQUENCY ($S_a(1-2.5\text{Hz})$) GROUND
 MOTIONS AT THE GGNS ESP SITE

High Frequency Deaggregation



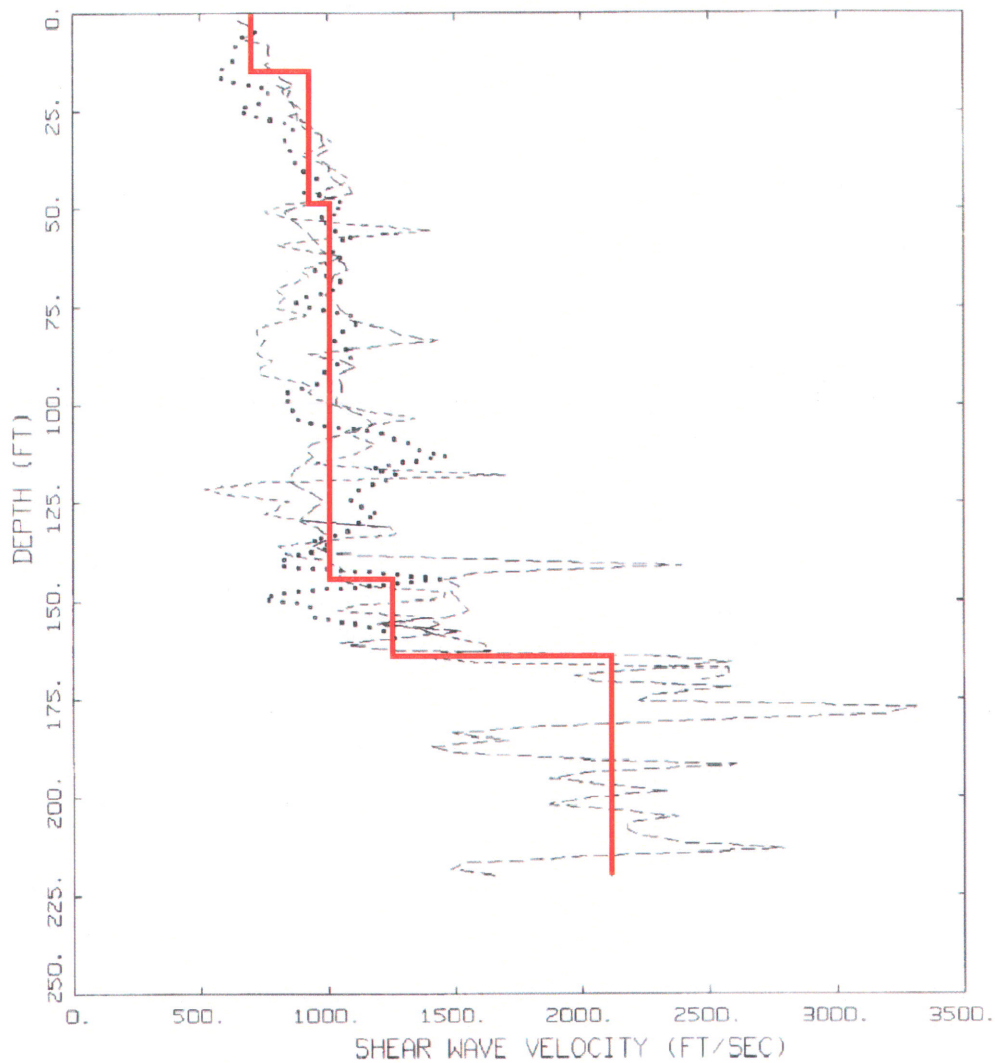
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DEAGGREGATION FOR HIGH
 FREQUENCY ($S_a(5-10\text{Hz})$) GROUND
 MOTIONS AND AT THE GGNS ESP SITE



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COMPARISON OF THE GGNS 10^{-5} MEDIAN
 UNIFORM HAZARD RESPONSE
 SPECTRUM AND THE MEDIAN RESPONSE
 SPECTRA ASSOCIATED WITH THE
 CONTROLLING EARTHQUAKES

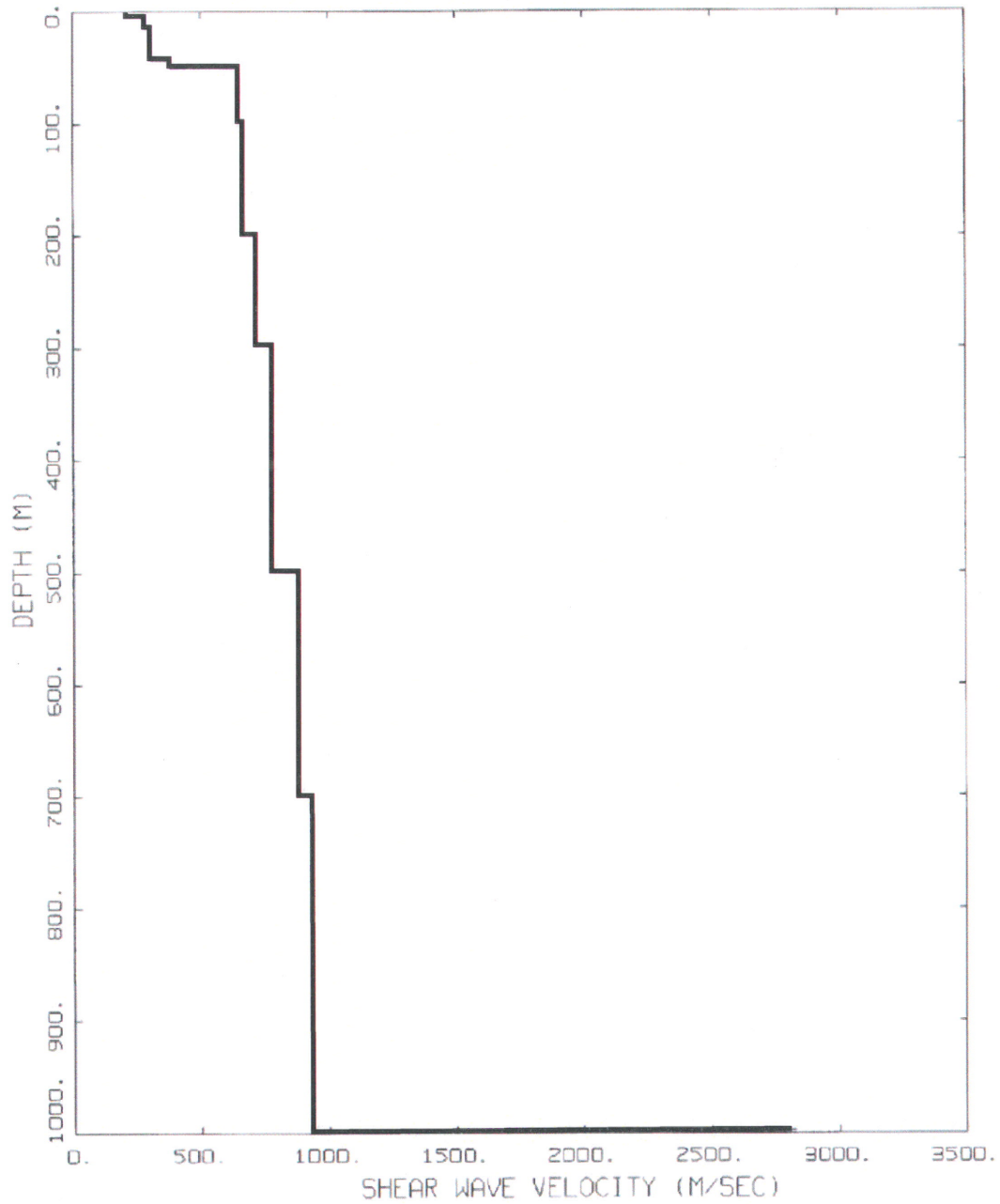


GRAND GULF
SITE SPECIFIC PROFILES

- LEGEND
- BASE CASE MODEL
 - PROFILE B-3
 - - - PROFILE B-2A
 - · - · PROFILE B-1

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BASE CASE SHEAR-WAVE VELOCITY PROFILE
AND SUSPENSION LOG MEASUREMENTS

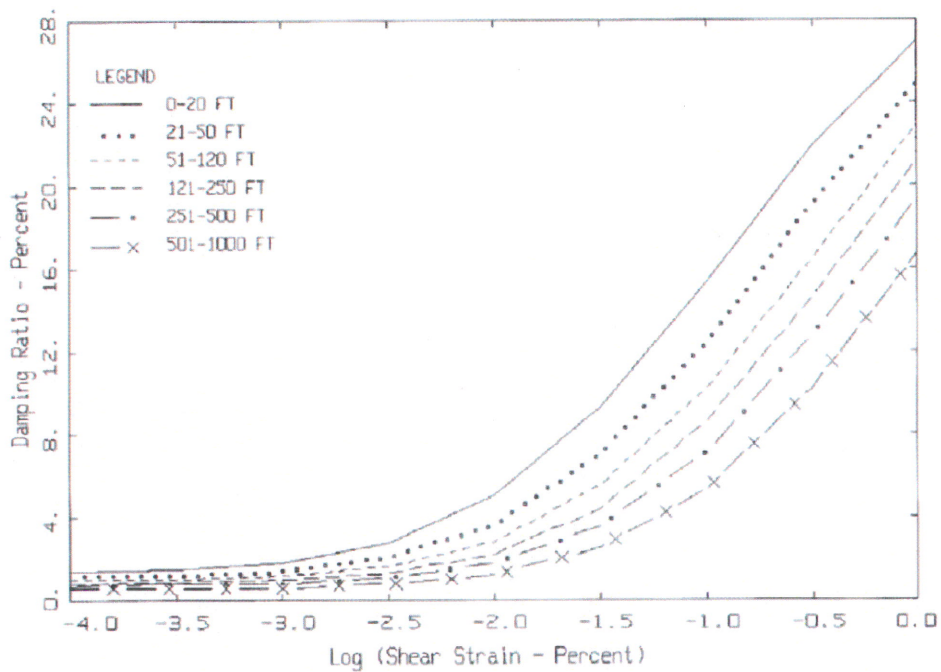
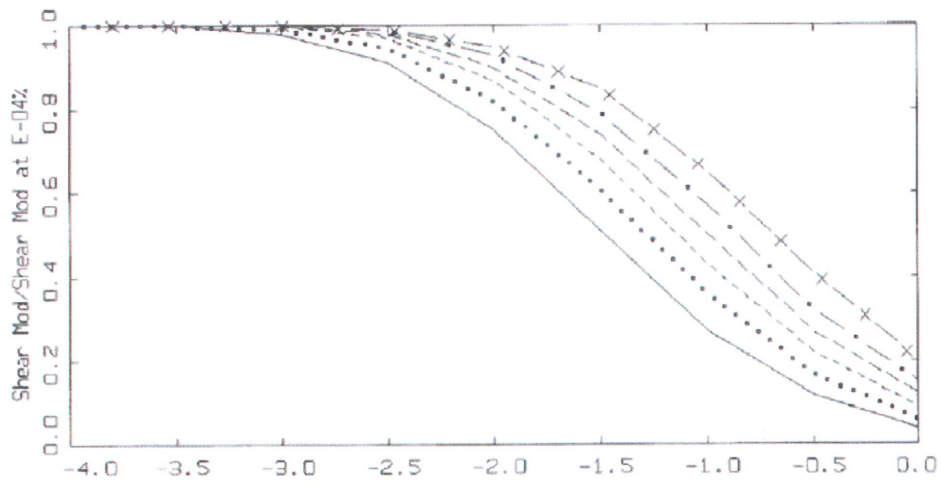


GRAND GULF
SITE SPECIFIC PROFILE

— LEGEND
BASE CASE MODEL TO 1 KM

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BASE CASE SHEAR-WAVE VELOCITY PROFILE
EXTENDED TO A DEPTH OF 1,000M

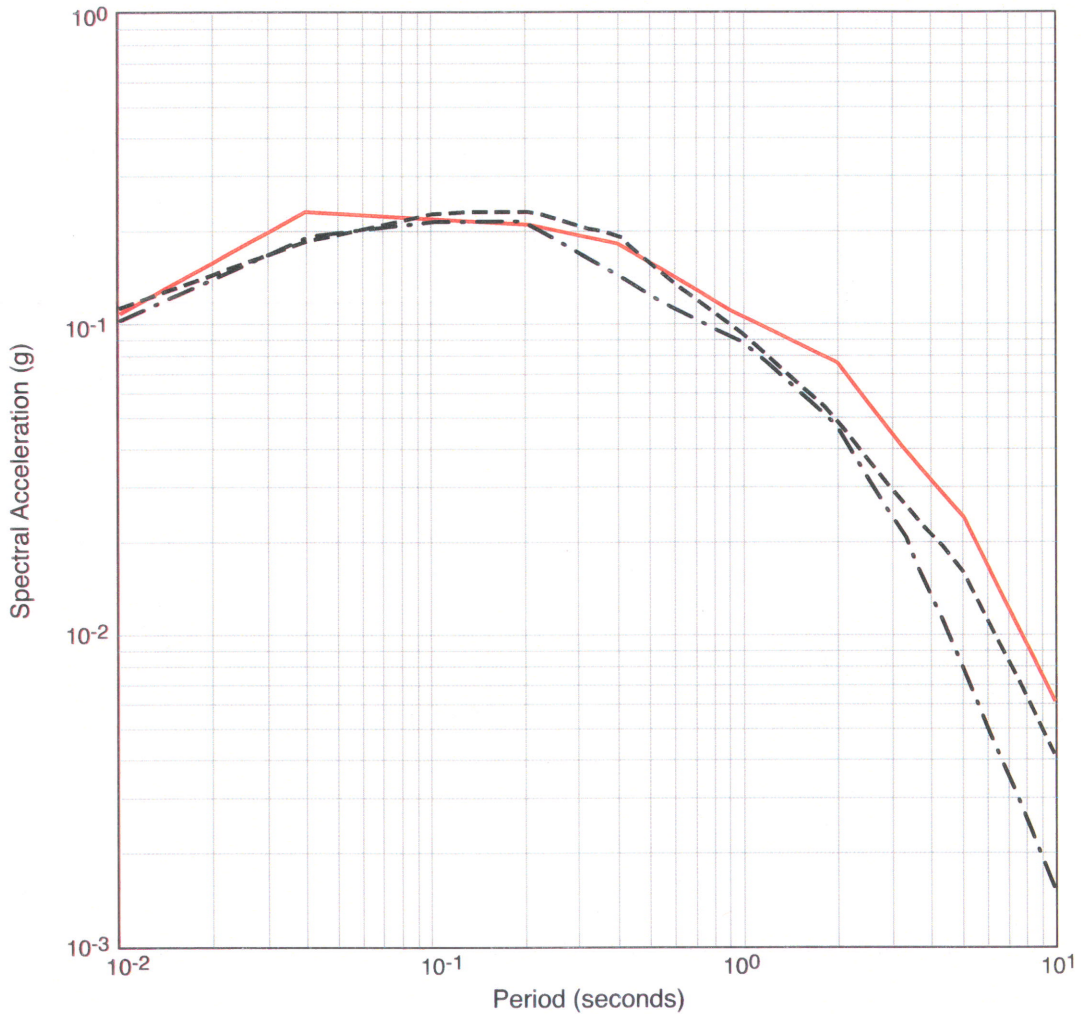


MODULUS REDUCTION AND DAMPING CURVES
EPRI(1993)

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COHESIONLESS SOIL MODULUS
REDUCTION AND DAMPING CURVES
(EPRI, 1993) ADOPTED FOR THE SITE

**GRAND GULF ROCK MOTIONS HORIZONTAL,
MEDIAN 10⁻⁵ ANNUAL PROBABILITY OF EXCEEDANCE (APE)**



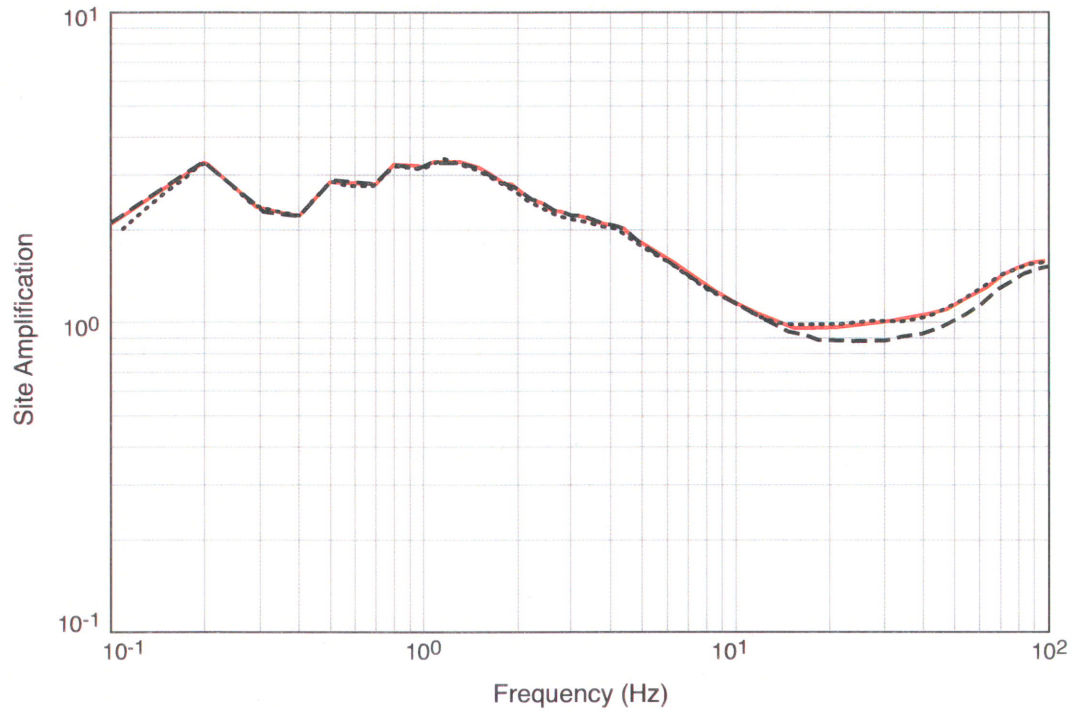
Explanation

- UHS; PGA = 0.109g
- · - · - 1 - 2 Hz; PGA = 0.113g
- - - - 5 - 10 Hz; PGA = 0.103g

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MEDIAN 10⁻⁵ APE UNIFORM HAZARD
RESPONSE SPECTRUM (UHS) AND
CORRESPONDING SCALED 1 TO 2 HZ AND 5
TO 10 HZ SPECTRA, EXTENDED TO 0.1 HZ
FOR SITE RESPONSE ANALYSES

TOP OF LOESS MEAN AMPLIFICATION



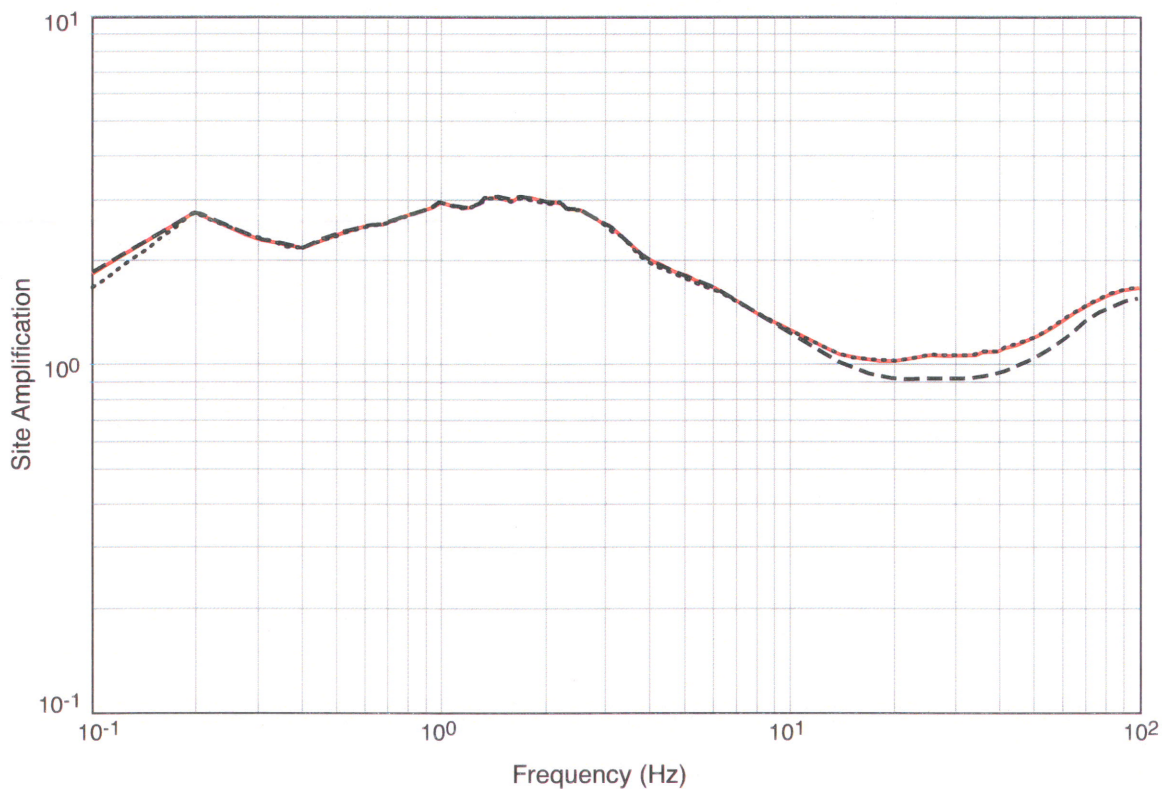
Explanation

- Envelope
- Mean 1 - 2 Hz
- - - - Mean 5 - 10 Hz

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MEAN TRANSFER FUNCTIONS
CORRESPONDING TO 1 TO 2 HZ AND 5 TO
10 HZ SCALED SPECTRA (FIGURE 2.5-63)
AND ENVELOPE: TOP OF LOESS

**TOP OF 1,000 FT/SEC MATERIAL
MEAN AMPLIFICATION**



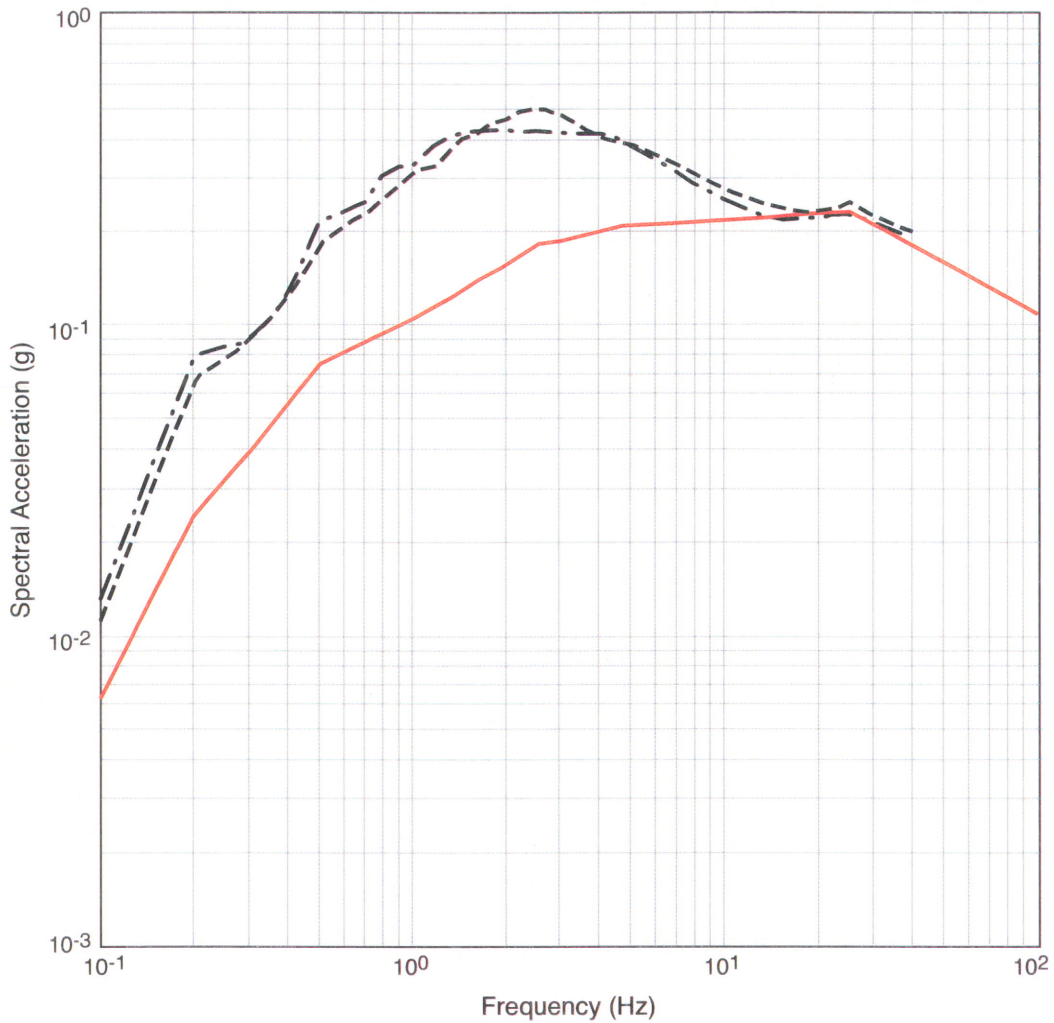
Explanation

- Envelope
- Mean 1 - 2 Hz
- - - - Mean 5 - 10 Hz

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MEAN TRANSFER FUNCTIONS CORRESPONDING
TO 1 TO 2 HZ SCALED SPECTRA (FIGURE 2.5-63)
AND ENVELOPE: TOP OF MATERIAL
WITH 1,000 FT/SEC SHEAR-WAVE VELOCITY,
DEPTH 50 FT (FIGURE 2.5-60)

**GRAND GULF SOIL MOTIONS HORIZONTAL,
MEDIAN 10⁻⁵ ANNUAL PROBABILITY OF EXCEEDANCE (APE)**



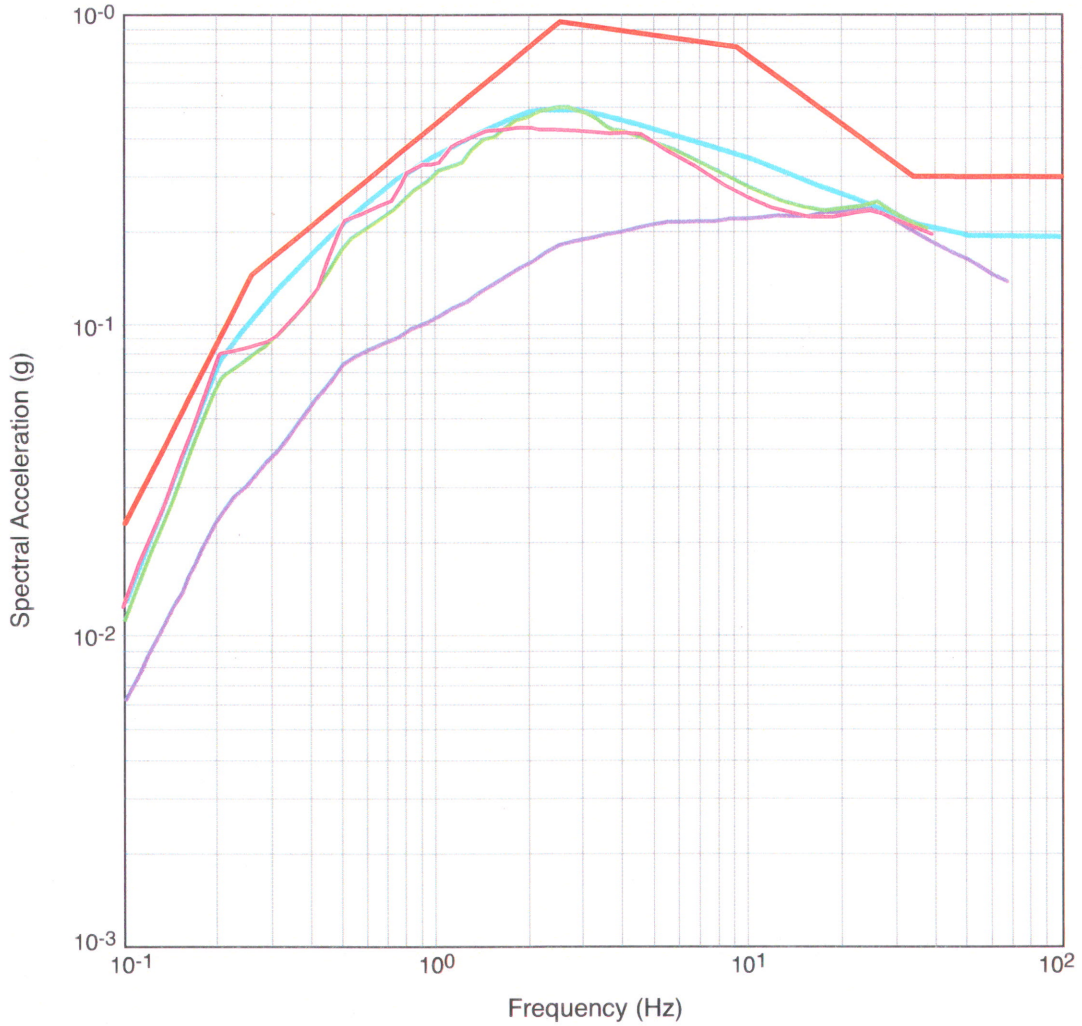
Explanation

- Rock UHS; PGA = 0.113g
- - - - - 1,000 ft/sec soil surface, 0.200g
- . - . - Top of loess, 0.192g

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HARD ROCK UNIFORM HAZARD RESPONSE
SPECTRUM (UHS) AND CORRESPONDING SOIL
MOTIONS: DASH-DOTTED, TOP OF LOESS; DASHED,
TOP OF MATERIAL WITH 1,000 FT/SEC
SHEAR-WAVE VELOCITY, 50 FT DEPTH (FIGURE 2.5-60)

GRAND GULF, MEDIAN 10⁻⁵ ANNUAL PROBABILITY OF EXCEEDANCE (APE) CONTROL MOTION SOIL DESIGN MOTION



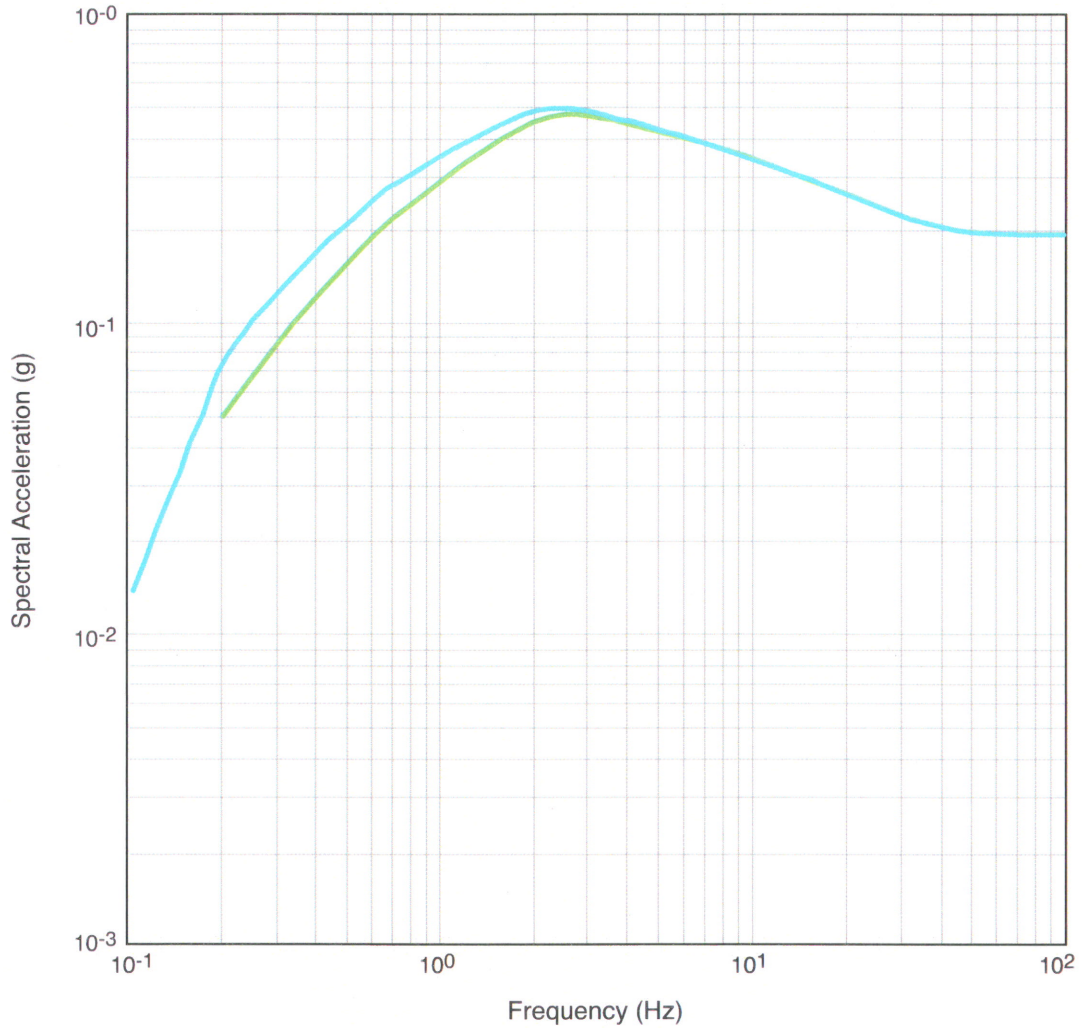
Explanation

- 5%, soil design motion, PGA = 1.90g
- 5%, 10⁻⁵ APE rock UGS, PGA = 1.09g
- 1,000 ft/sec soil surface, 0.182g
- Top of loess, 0.174g
- 5%, regulatory guide 160 scaled to 0.3g

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HORIZONTAL SOIL DESIGN GROUND MOTION (BLUE) AS ENVELOPE OF TOP OF LOESS MOTION AND MOTION WITH TOP 50 FT OF LOESS REMOVED (GREEN). NRC REGULATORY GUIDE 1.60 SPECTRUM SCALED TO 0.3G (RED)

**GRAND GULF, MEDIAN 10⁻⁵ ANNUAL PROBABILITY OF EXCEEDANCE (APE)
VERTICAL MOTION AT SOIL SURFACE**



Explanation

- Vertical soil design motion, PGA = 1.90g
- 5%, horizontal soil design motion, PGA = 0.190g

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VERTICAL SOIL DESIGN MOTION BASED ON
NRC REGULATORY GUIDE 1.60 V/H RATIOS

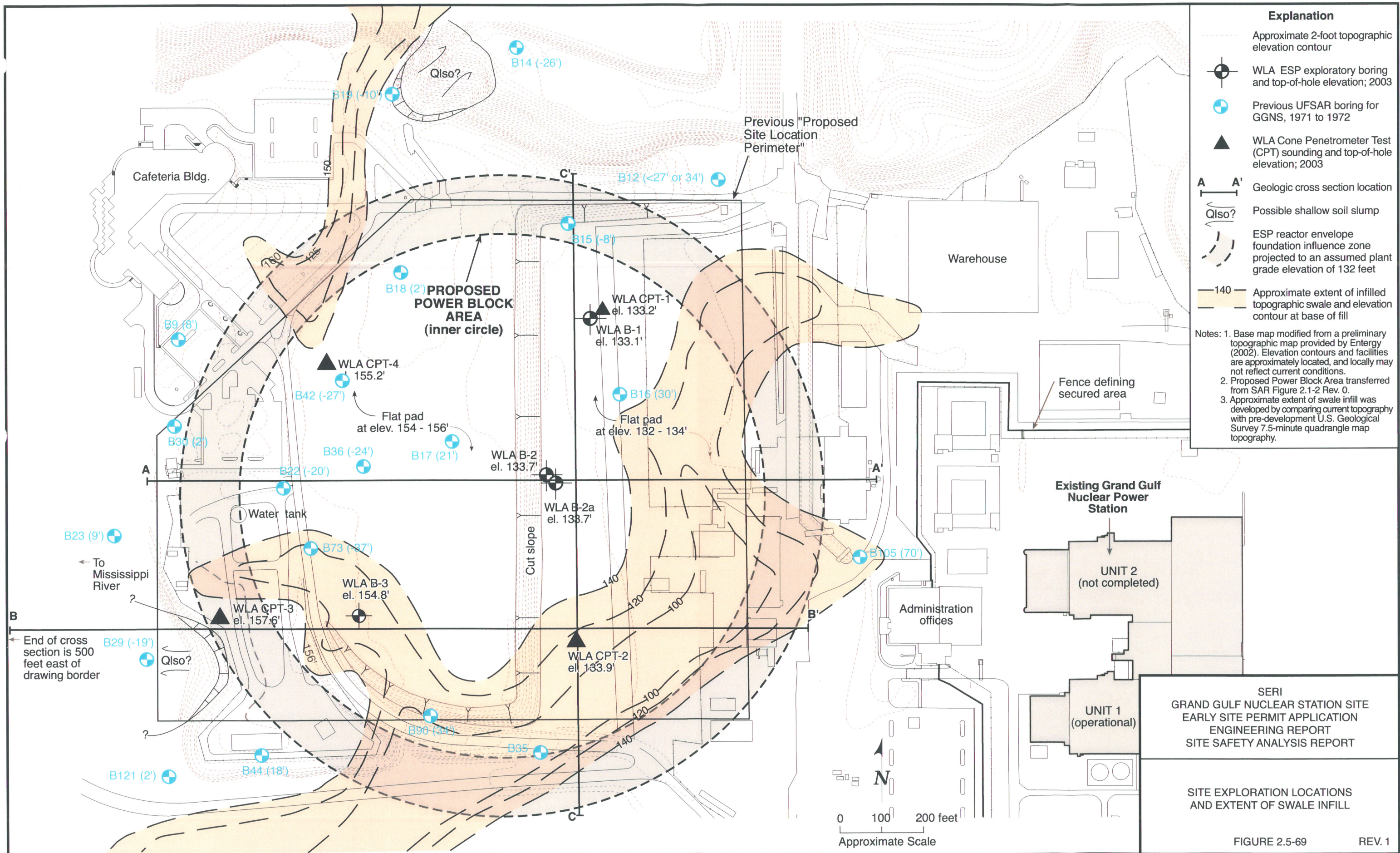
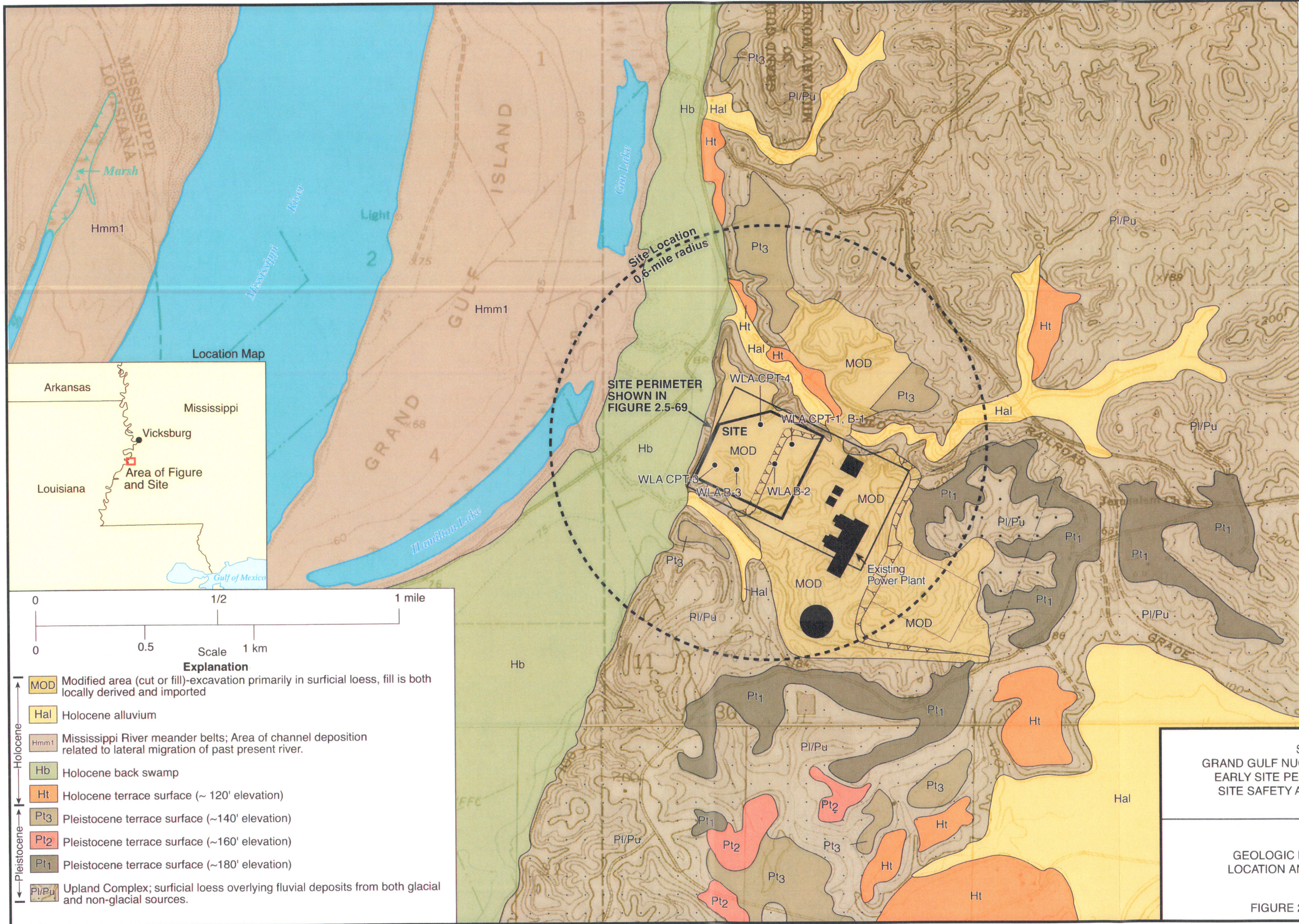


FIGURE 2.5-69 REV. 1



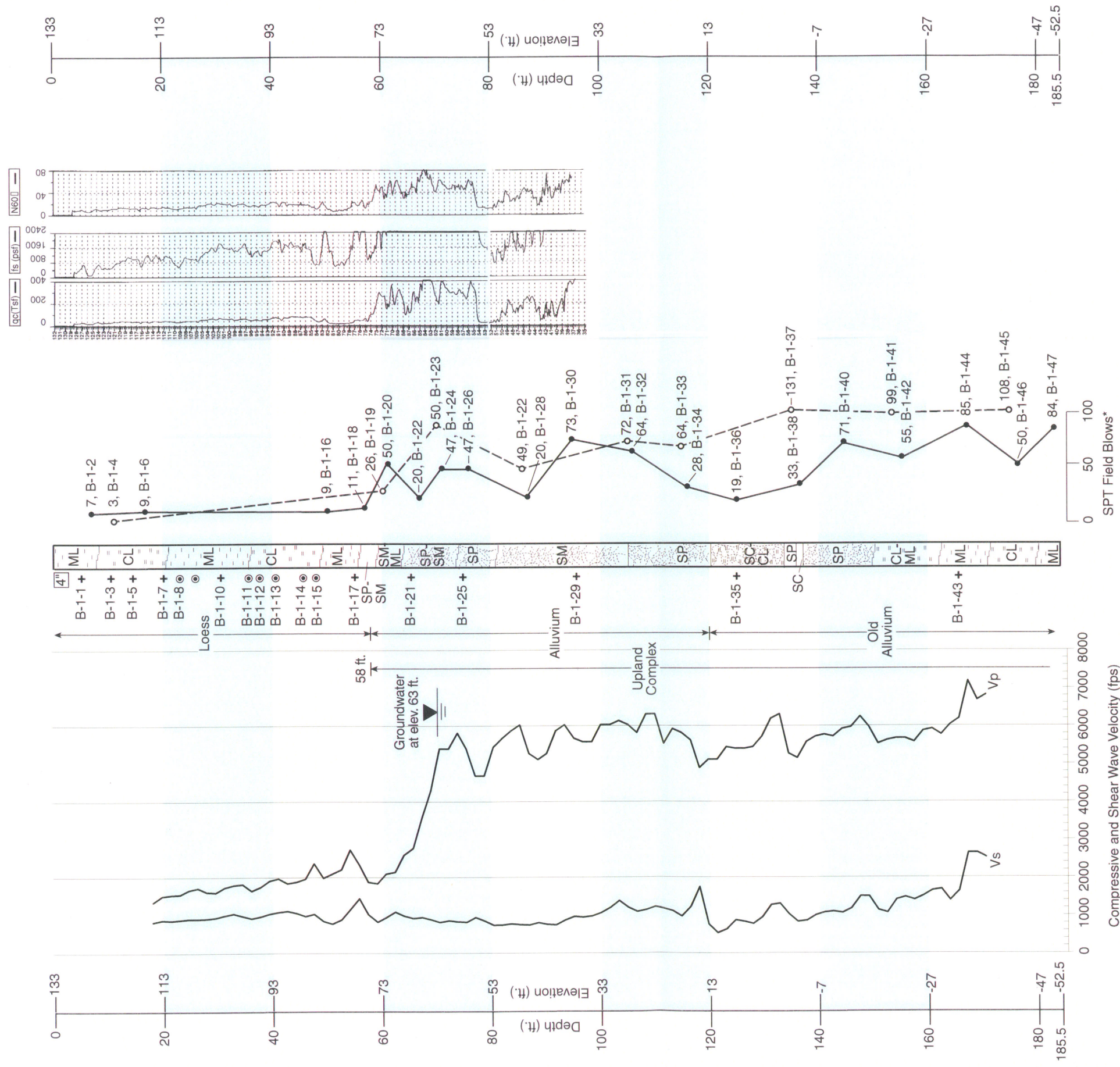
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GEOLOGIC MAP OF SITE
LOCATION AND SITE AREA

FIGURE 2.5-70

REV. 1

P-S Logger Velocity Profile	Geologic Units	Log of Boring WLA-B-1	Plot of SPT Blow Counts	Cone Penetration Test CPT-1
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- Notes:
- Downhole geophysics in uncased hole performed by T. Martin of Geovision.
 - Groundwater level interpreted from geophysical log.
 - Vs = Shear Wave Velocity
Vp = Compressional Wave Velocity
 - CPT-1 is located approximately 10 feet northeast of B-1.
 - Elevation of ground surface at boring is 133.2 feet.
 - Boring started on July 24, and completed July 30, 2002.
 - SPT field blows determined with a 140 lb. hammer, and 30" drop.

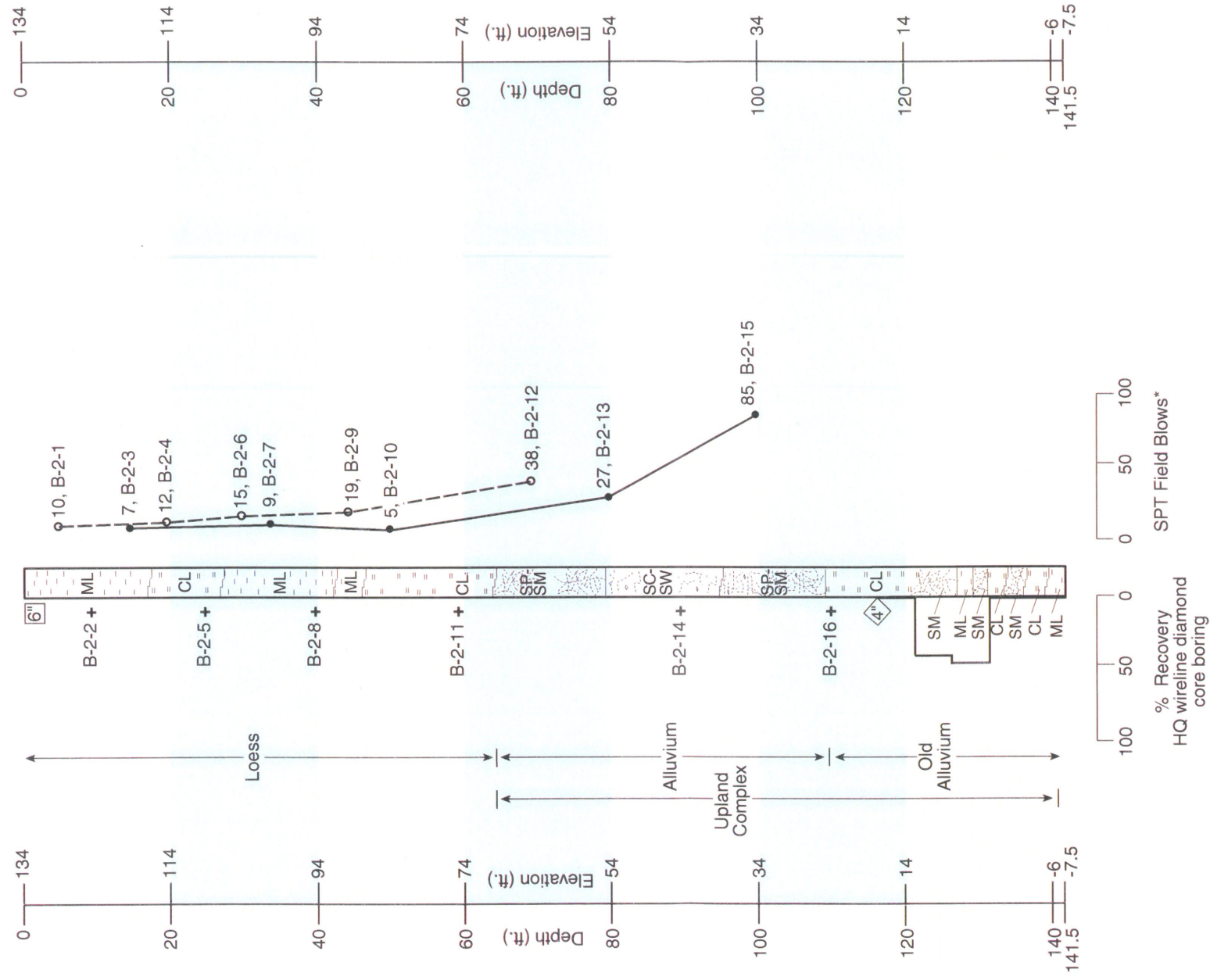
Explanation
Sampler type and number
● SPT sampler
⊙ SPT sampler (pushed)
○ 3.0" O.D. "ModCal" sampler
+ 3.0" O.D. thin wall Shelby sampler (pushed)
4" Mud rotary hole diameter

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BORING SUMMARY SHEET
 BORING WLA B-1

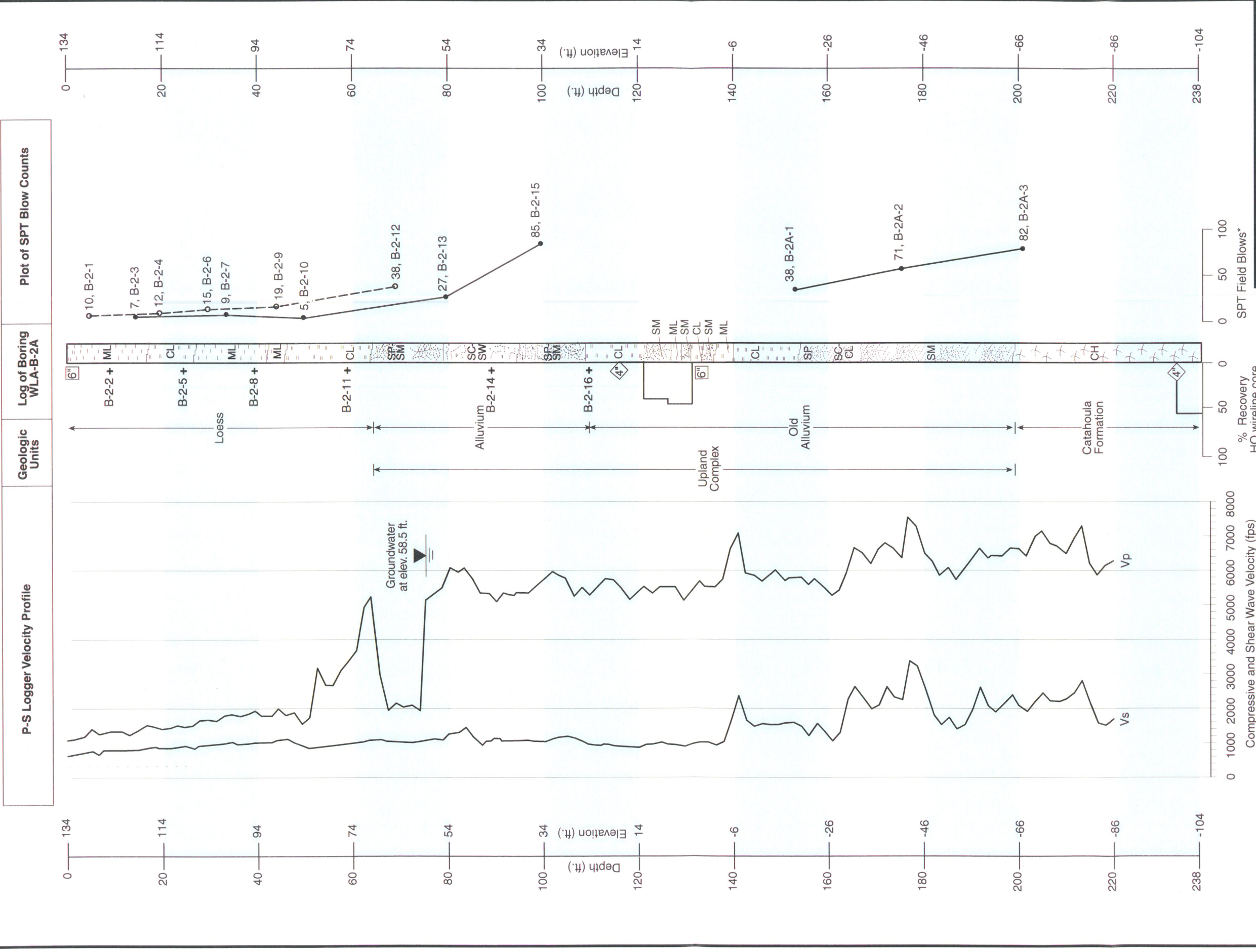
FIGURE 2.5-71 REV. 1

Geologic Units	Log of Boring WLA-B-2	Plot of SPT Blow Counts
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Explanation
Sampler type and number
• SPT sampler
○ 3.0" O.D. "ModCal" sampler
+ 3.0" O.D. thin wall Shelby sampler (pushed)
6" Wireline corehole diameter
4" Wireline corehole diameter

- Notes:
- Elevation of ground surface at boring is 133.6 feet.
 - Boring started on July 30, 2002, and completed on August 2, 2002
 - SPT field blows determined with a 140 lb. hammer, and 30" drop.

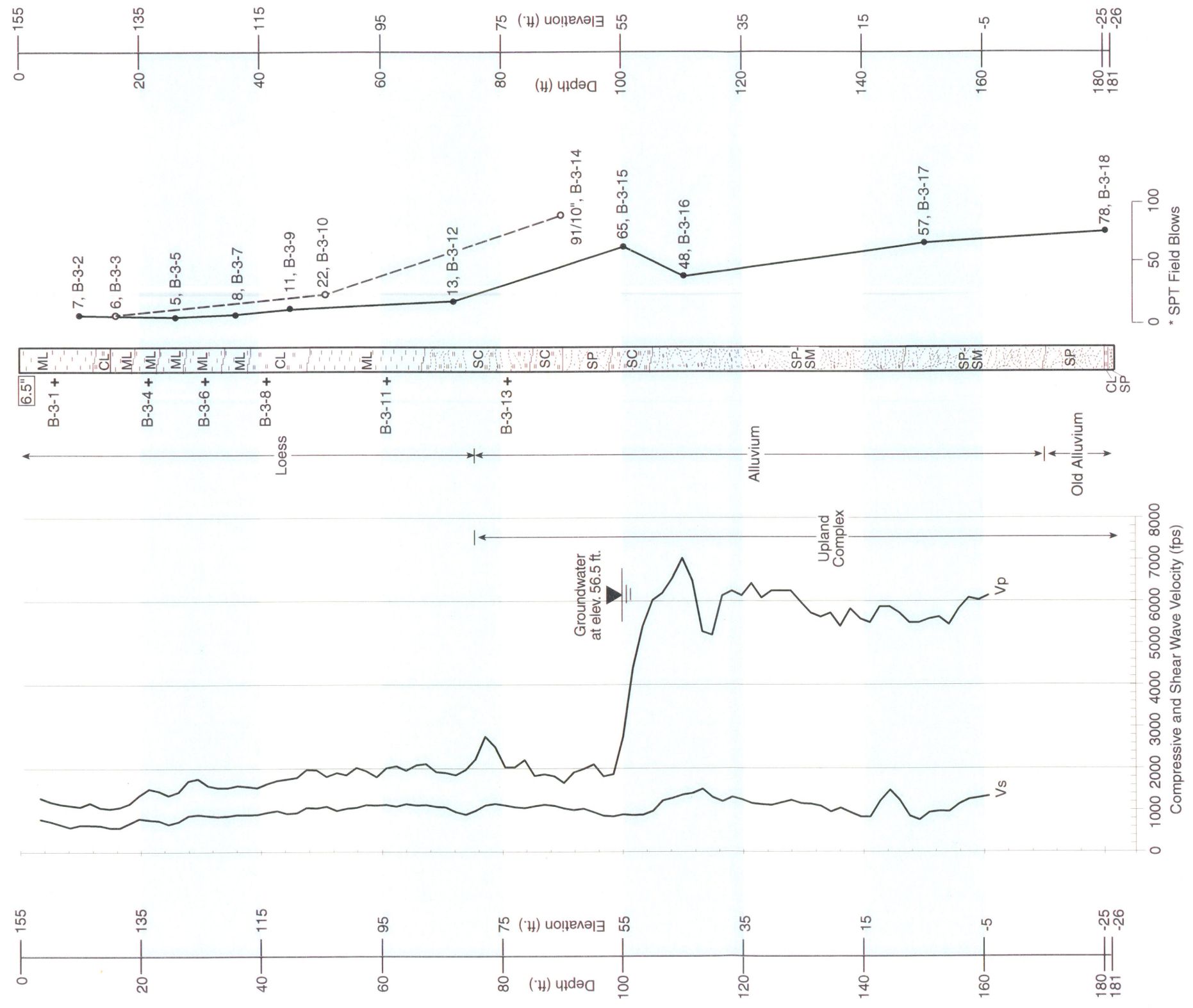


- Notes:
1. Downhole geophysics in bald hole performed by T. Martin of Geovision.
 2. Groundwater level interpreted from geophysical log.
 3. Vs = Shear Wave Velocity Vp = Compressional Wave Velocity
 4. Elevation of ground surface at boring is 133.7 feet.
 5. Boring started August 8, 2002, and completed on August 19, 2002.
 6. SPT field blows determined with a 140 lb. hammer, and 30" drop.

Explanation

- SPT sampler
- 3.0" O.D. "ModCal" sampler
- + 3.0" O.D. thin wall Shelby sampler (pushed)
- 6" Mud rotary hole diameter
- 4" Wireline corehole diameter

P-S Logger Velocity Profile **Geologic Units** **Log of Boring WLA-B-3** **Plot of SPT Blow Counts**



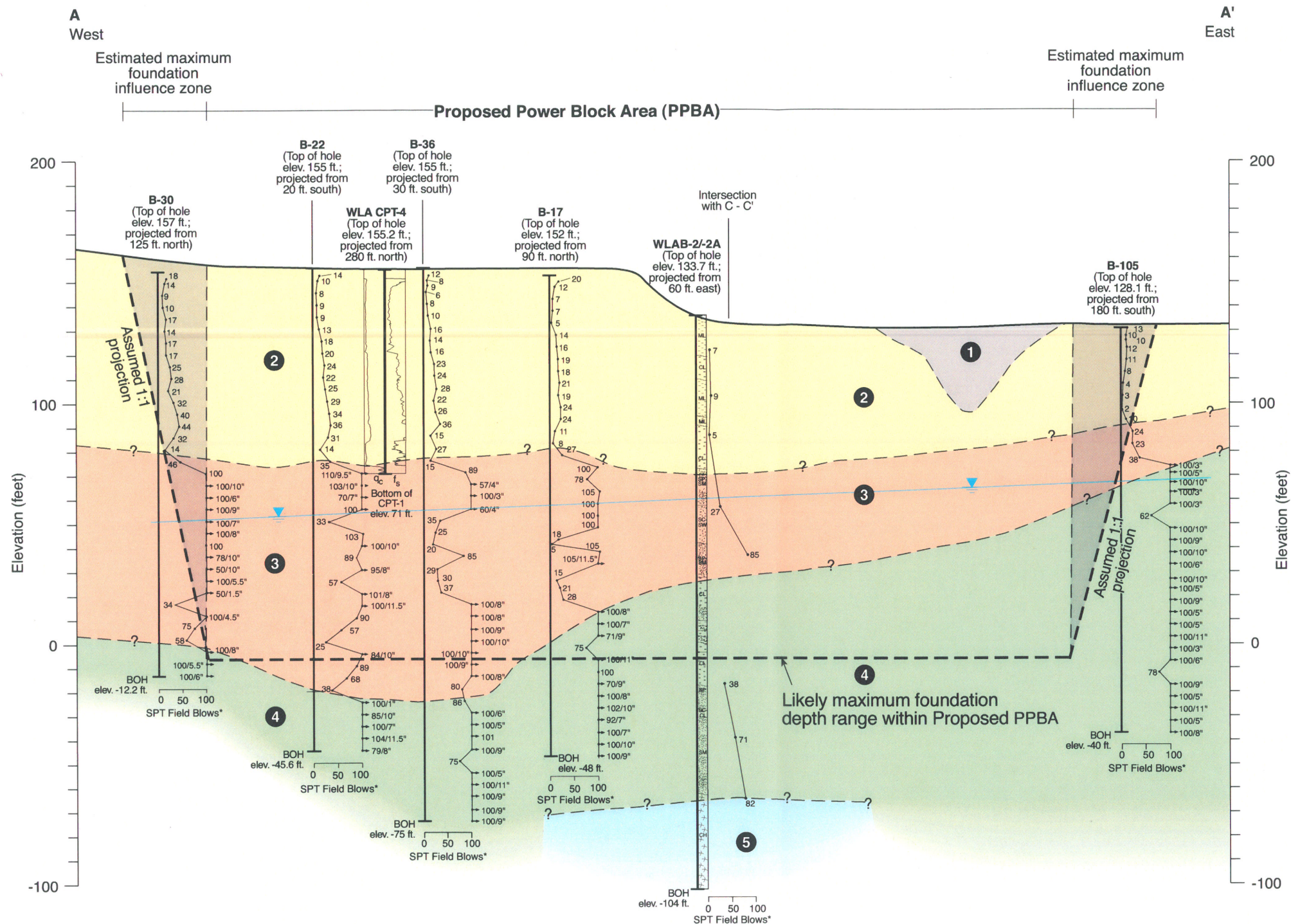
Notes:
 1. Downhole geophysics in bald hole performed by T. Martin of Geovision.
 2. Groundwater level interpreted from geophysical log.
 3. Vs = Shear Wave Velocity Vp = Compressional Wave Velocity
 4. Elevation of ground surface at boring is 154.8 feet
 5. Boring started on August 12, 2002 and completed on August 15, 2002
 6. SPT field blows determined with a 140 lb. hammer, and 30" drop

* Blows determined with a 140 lb. hammer, 30" drop.

Explanation
Sampler type and number
• SPT sampler
○ 3.0" O.D. "ModCal" sampler
+ 3.0" O.D. thin wall Shelby sampler (pushed)
6.5" Mud rotary hole diameter

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BORING SUMMARY SHEET,
 BORING B-3



- Explanation**
- 1 Fill (infilled topographic swale)
 - 2 Loess
 - 3 Alluvium
 - 4 Old alluvium
 - 5 Catahoula Formation
- Upland Complex (encompassing layers 3 and 4)
- Groundwater table measured in July/August 2002 by P-S geophysical logging

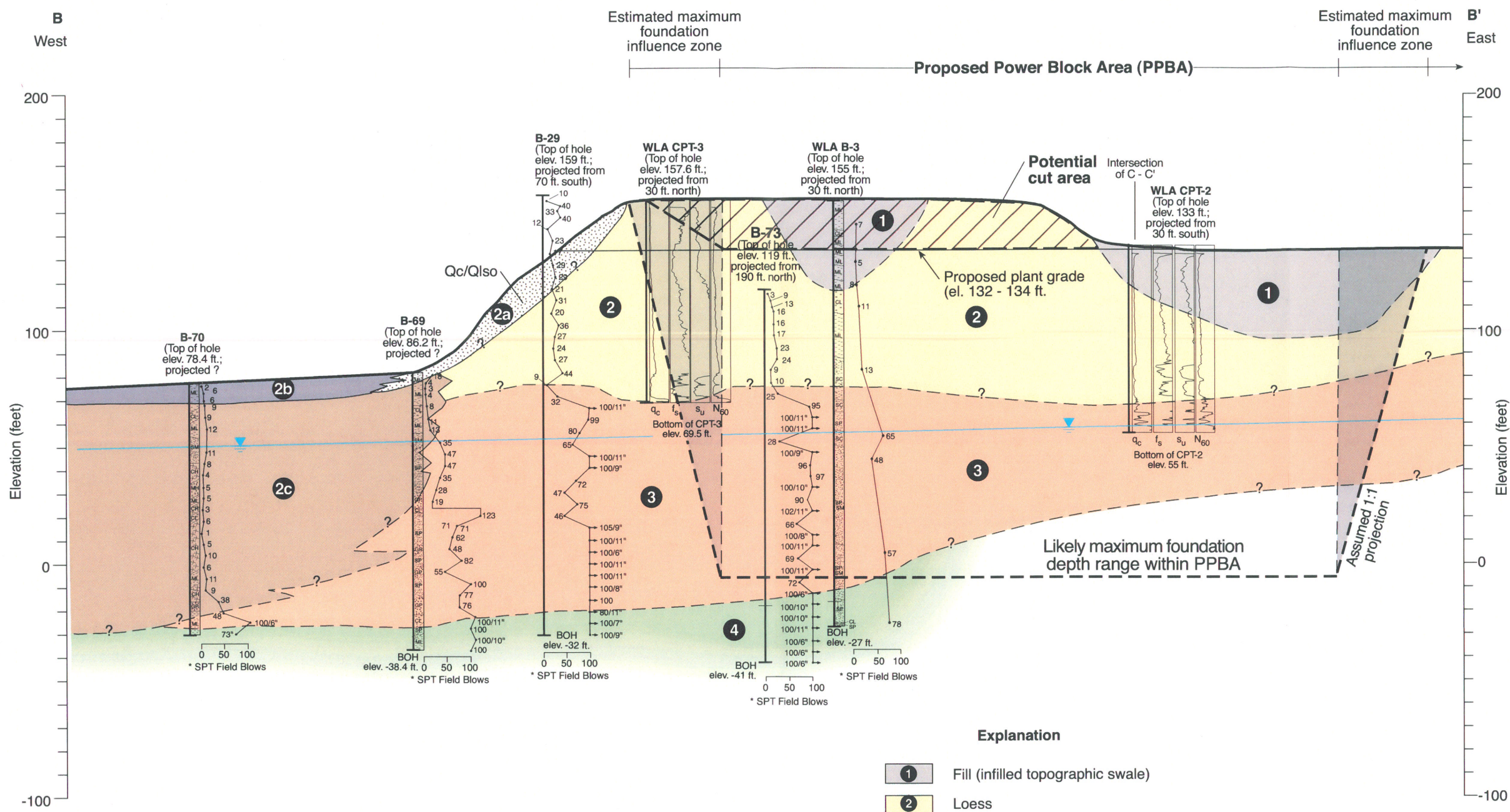
Notes: 1. SPT blow counts are uncorrected field blows, and WLA boring SPT data were collected with an automatic trip hammer.
 2. Borings with preface "B" are from GGNS UFSAR.

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GEOLOGIC SECTION A - A'

FIGURE 2.5-75

REV. 1



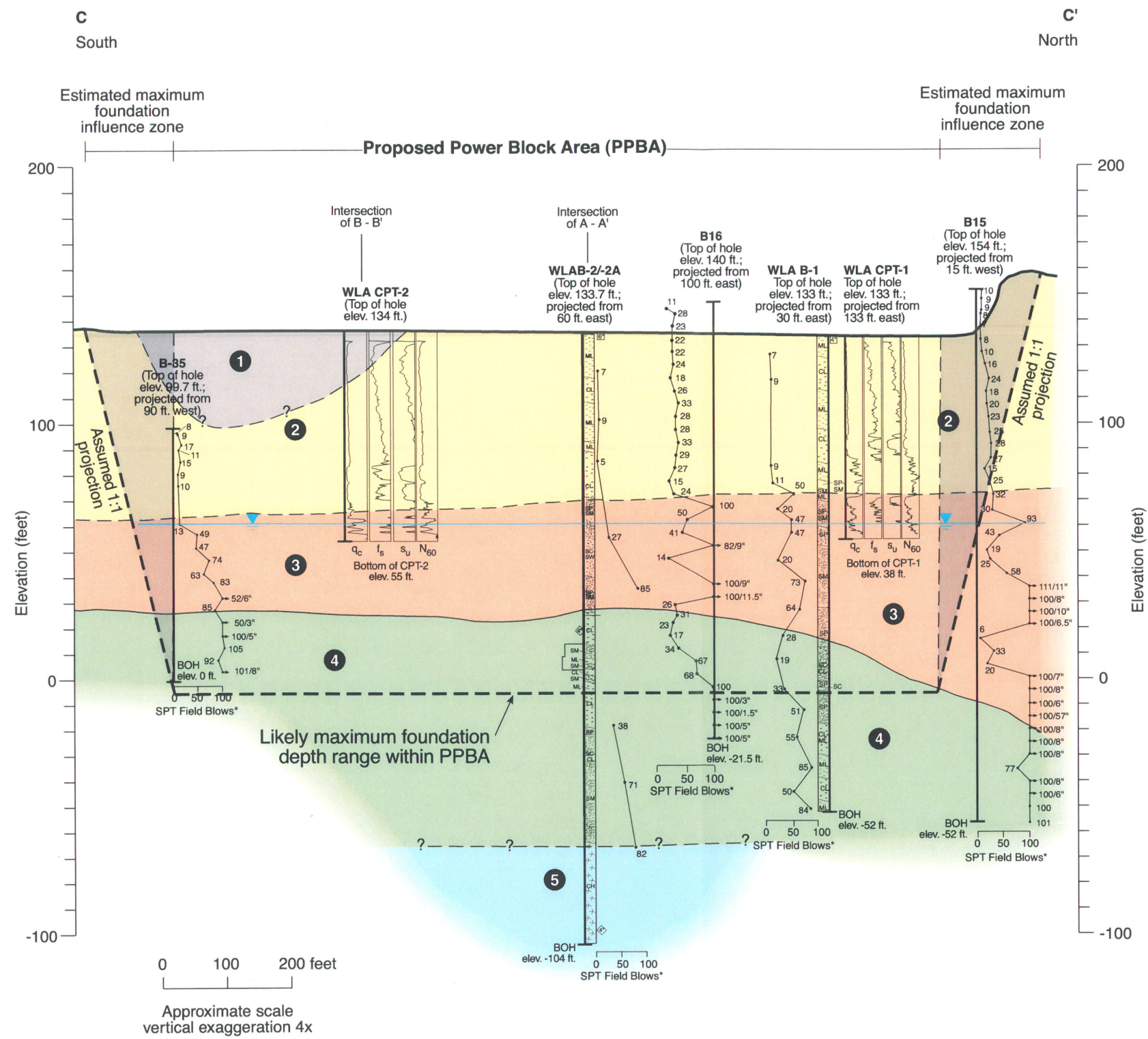
0 100 200 feet
 Approximate scale
 vertical exaggeration 4x

- Explanation**
- 1 Fill (infilled topographic swale)
 - 2 Loess
 - 2a Colluvium and/or old landslide deposits derived from loess
 - 2b Overbank silt deposits
 - 2c Mississippi River alluvium
 - 3 Alluvium
 - 4 Old alluvium
 - Groundwater table measured in July/August 2002 by P-S geophysical logging
 - Potential cut area

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GEOLOGIC SECTION B - B' (EXTENDED)

FIGURE 2.5-76 REV. 1



Explanation

1	Fill (infilled topographic swale)	
2	Loess	
3	Alluvium	Upland Complex
4	Old alluvium	
5	Catahoula Formation	
	Groundwater table measured in July/August 2002 by P-S geophysical logging	

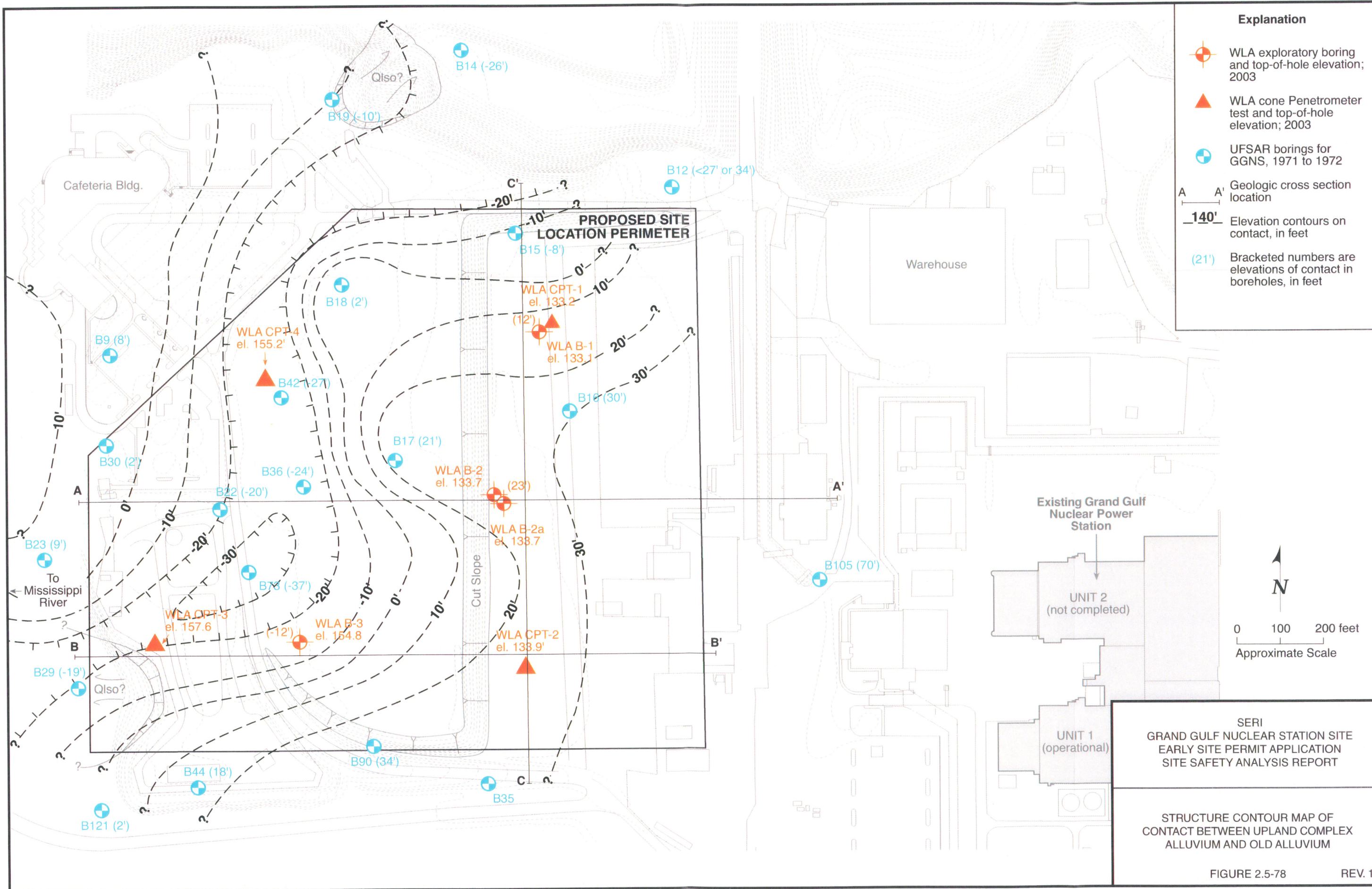
Notes: 1. SPT blow counts are uncorrected field blows, and WLA boring SPT data were collected with an automatic trip hammer.
 2. Borings with preface "B" are from GGNS UFSAR.

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GEOLOGIC SECTION C - C'

FIGURE 2.5-77

REV. 1



Explanation	
	WLA exploratory boring and top-of-hole elevation; 2003
	WLA cone Penetrometer test and top-of-hole elevation; 2003
	UFSAR borings for GGNS, 1971 to 1972
A A'	Geologic cross section location
	140' Elevation contours on contact, in feet
	(21') Bracketed numbers are elevations of contact in boreholes, in feet

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STRUCTURE CONTOUR MAP OF
 CONTACT BETWEEN UPLAND COMPLEX
 ALLUVIUM AND OLD ALLUVIUM