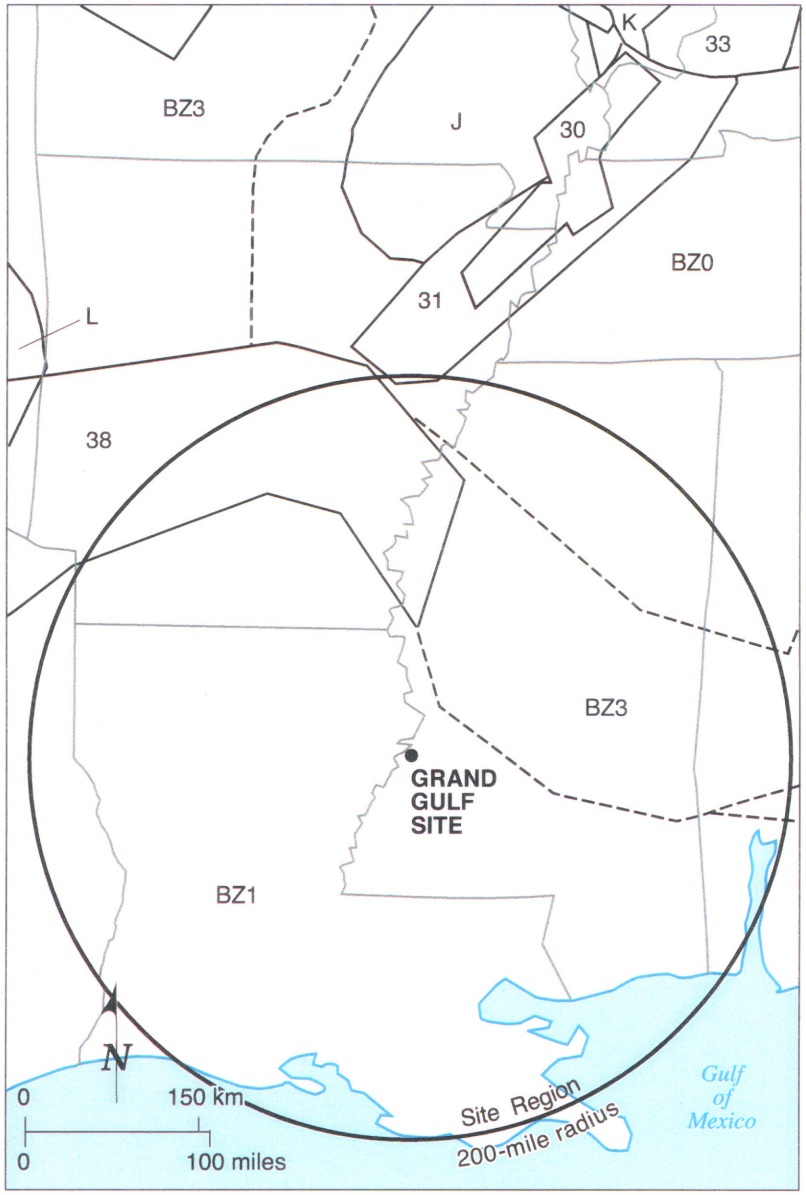

Summary of Bechtel Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
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]
Selected sources beyond 200 mi (320 km)					
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

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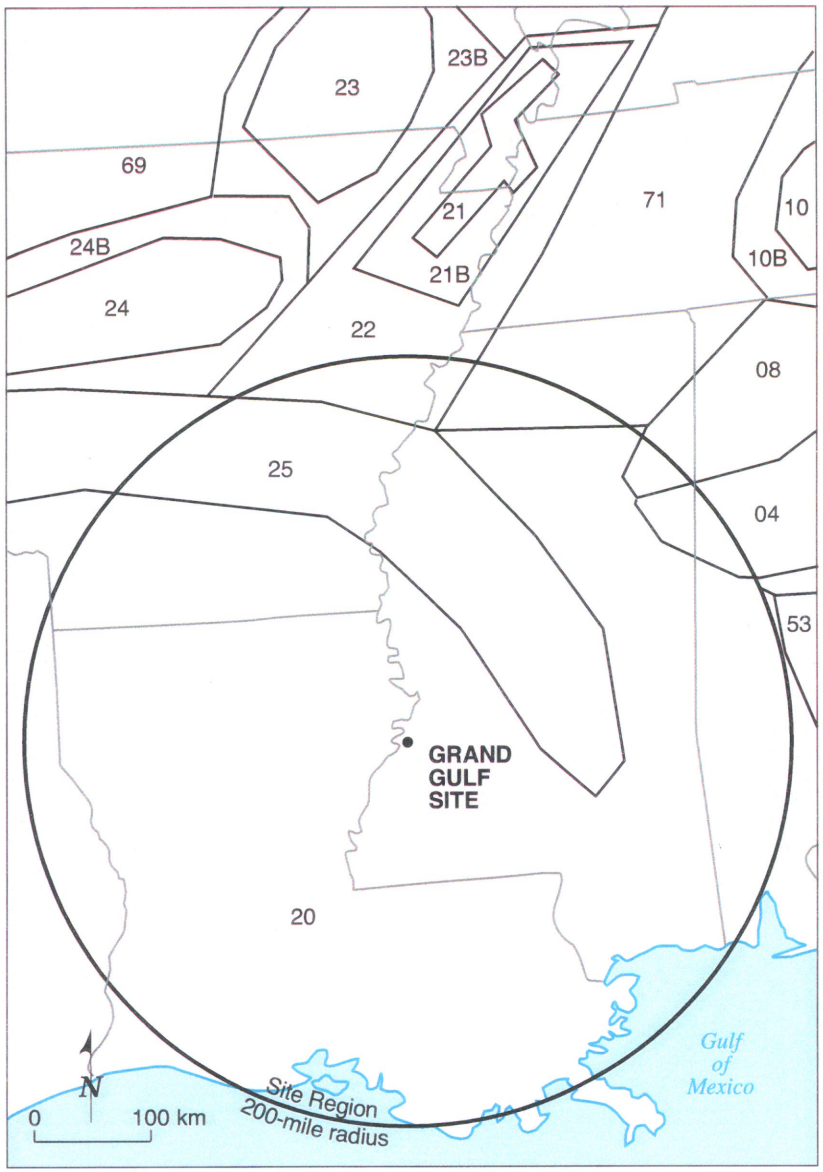
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

EPRI SOG
SEISMIC SOURCE ZONES
BECHTEL TEAM

FIGURE 2.5-39 REV. 1



Summary of Dames & Moore Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (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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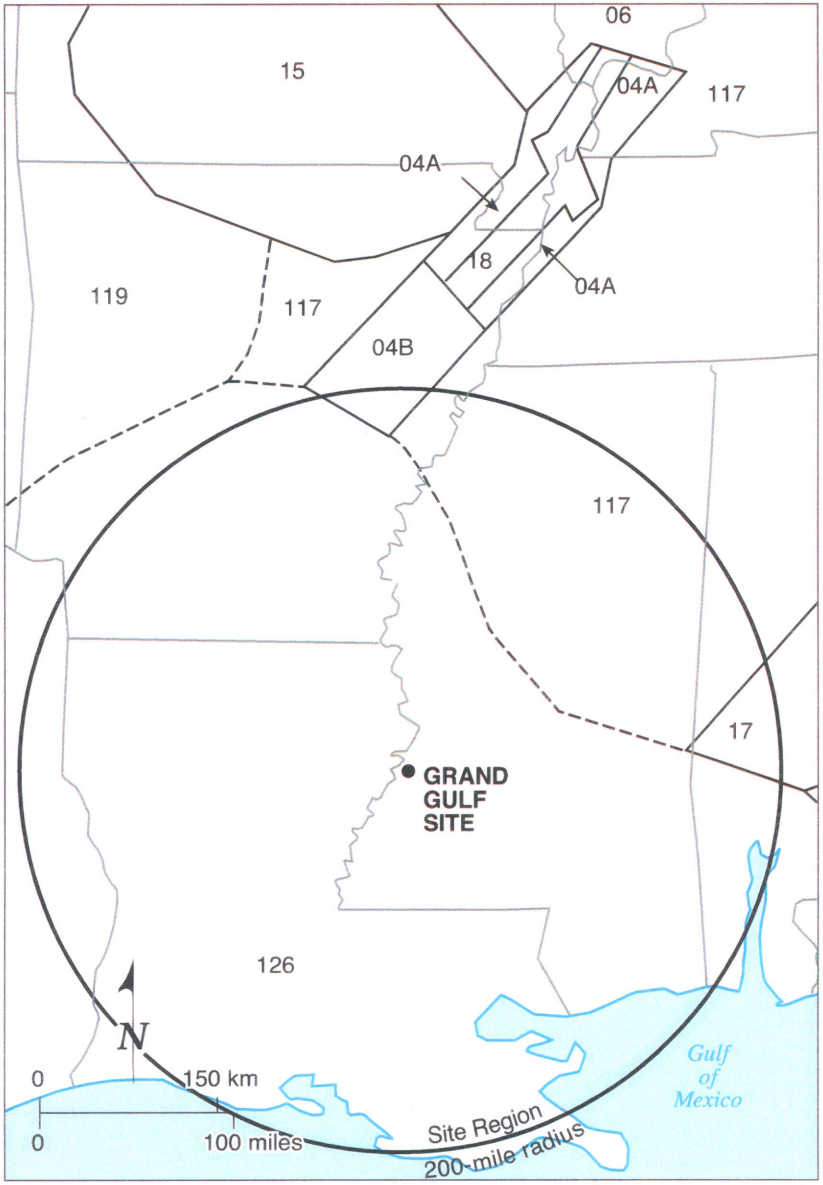
DAMES & MOORE TEAM

FIGURE 2.5-40 REV. 1



Summary of Law Engineering Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
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]
Selected sources beyond 200 mi (320 km)					
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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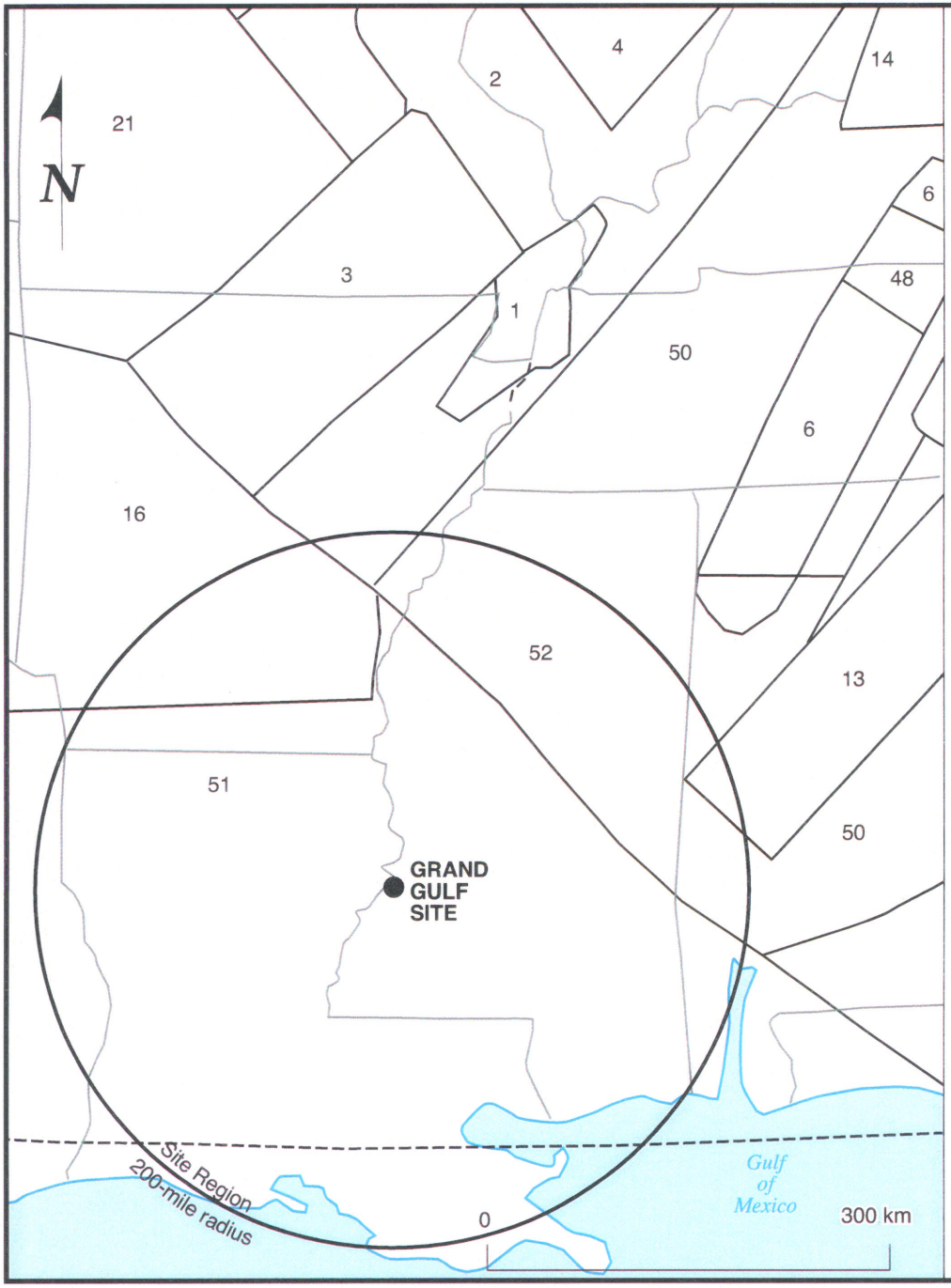
SEISMIC SOURCE ZONES
LAW ENGINEERING TESTING COMPANY TEAM

FIGURE 2.5-41 REV. 1



Summary of Rondout Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
51	Gulf Coast/Bahamas	0	0	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]
16	Southern Oaklahoma Aulacogen/ Ouachita	100	161.0306	1.00	5.8 [0.15] 6.5 [0.60] 6.8 [0.25]
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]
Selected sources beyond 200 mi (320 km)					
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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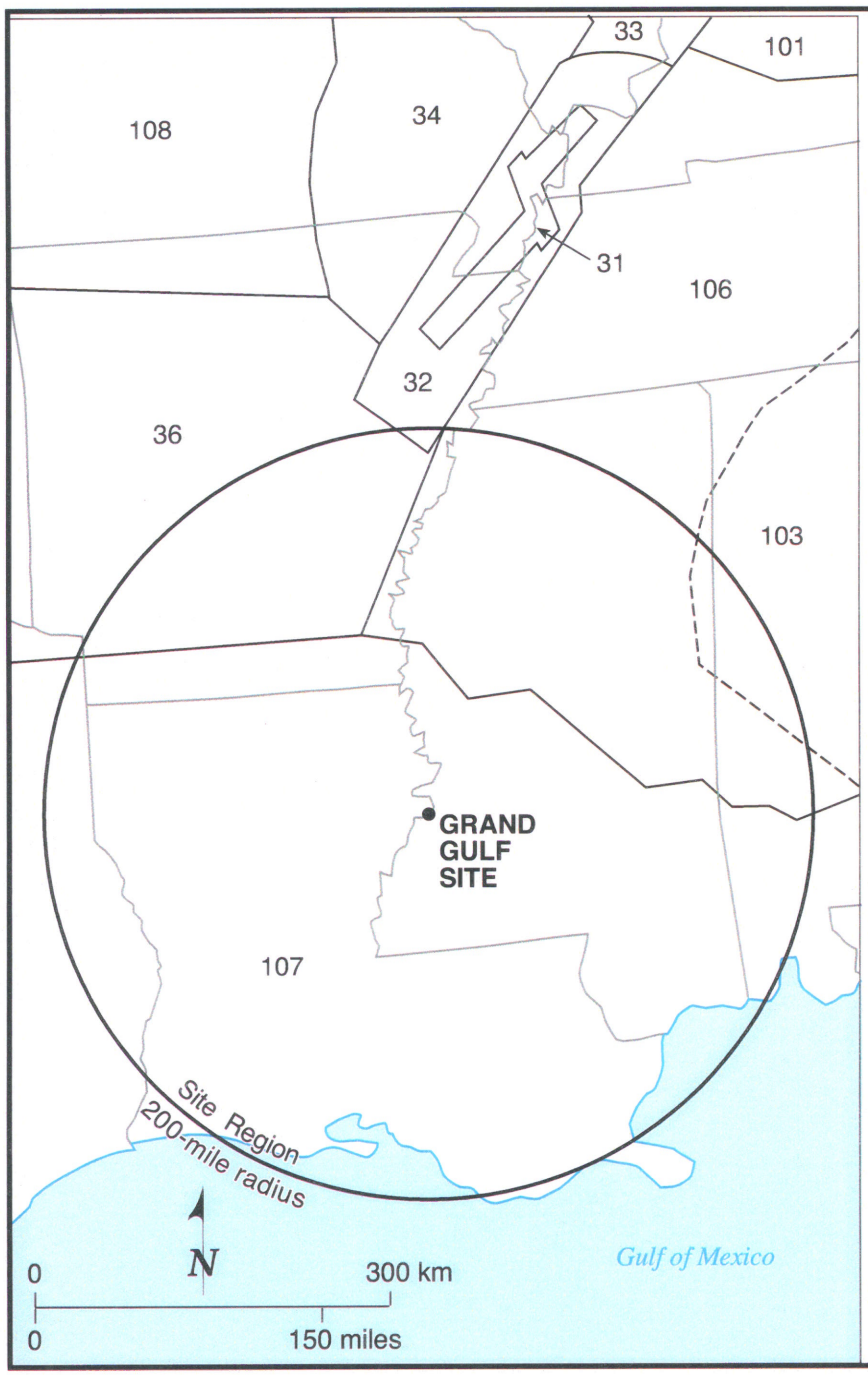
SEISMIC SOURCE ZONES
RONDOUT ASSOCIATES TEAM

FIGURE 2.5-42 REV. 1



Summary of Weston Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
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	Backgroun 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]
C11	Combined 32 & 31	185	297.9066	N.A.	6.0 [0.13] 6.6 [0.77] 7.2 [0.10]
Selected sources beyond 200 mi (320 km)					
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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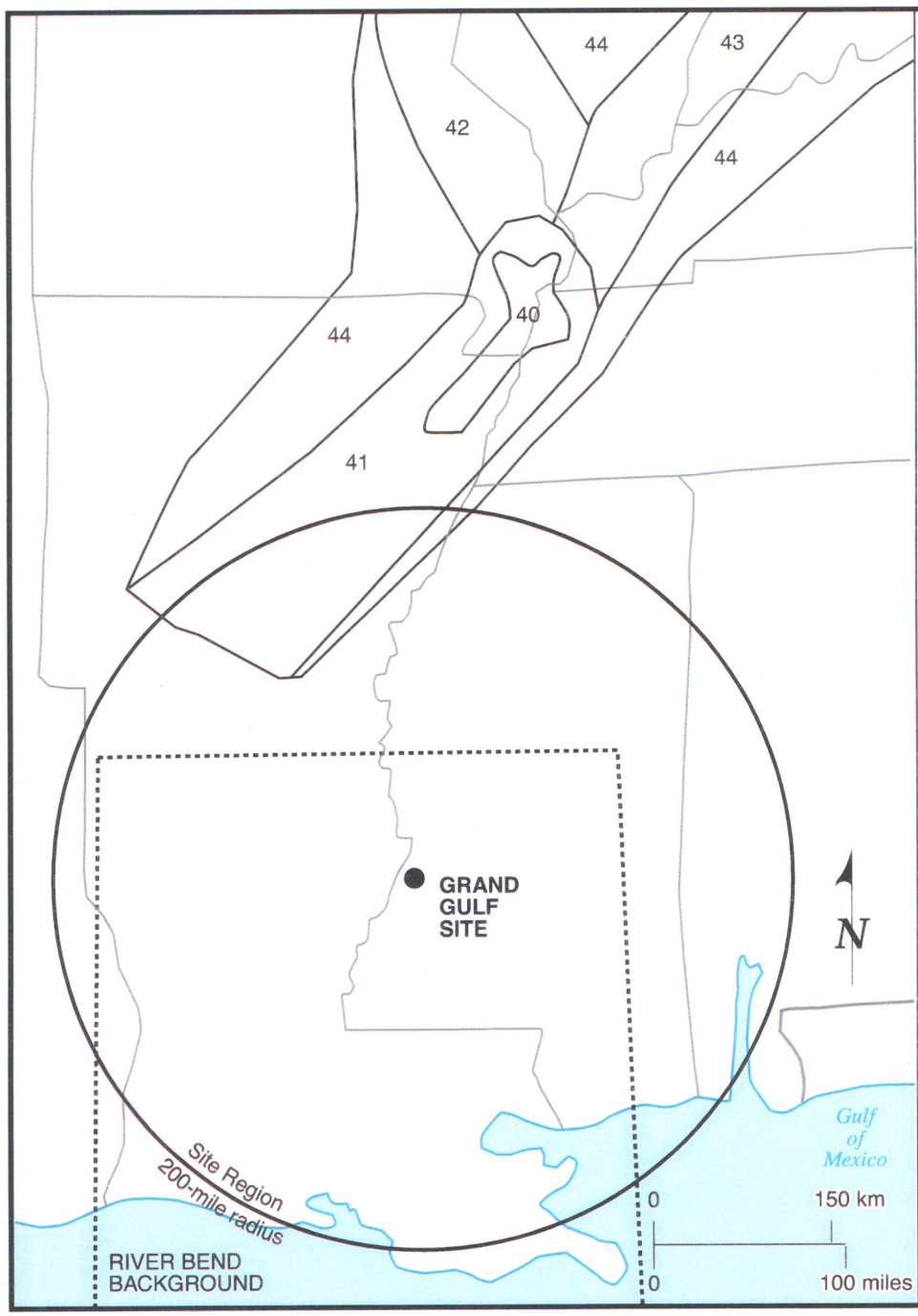
EPRI SOG
SEISMIC SOURCE ZONES
WESTON GEOPHYSICAL CORPORATION TEAM

FIGURE 2.5-43 REV. 1



Summary of Woodward-Clyde Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
	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]
Selected sources beyond 200 mi (320 km)					
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 Woodwar 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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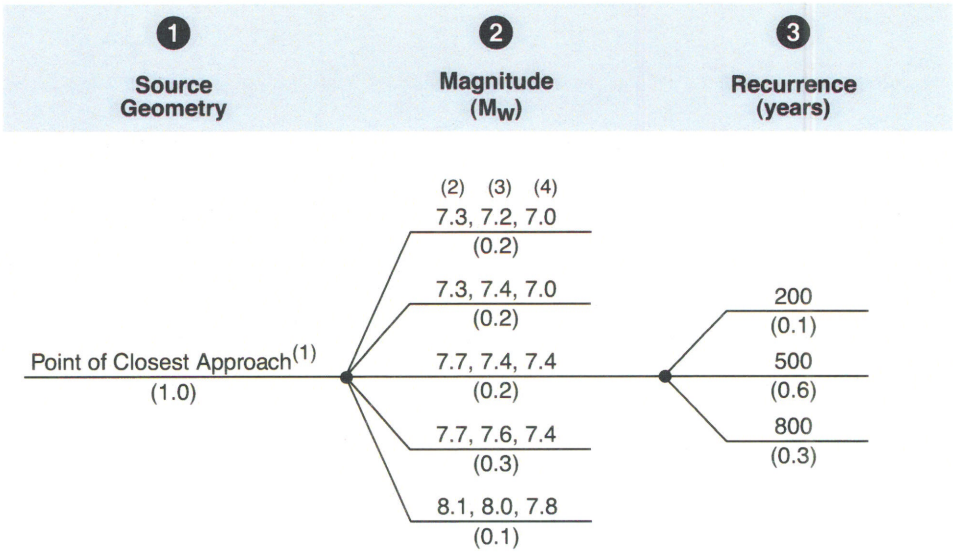
SEISMIC SOURCE ZONES
WOODWARD CLYDE CONSULTANTS TEAM

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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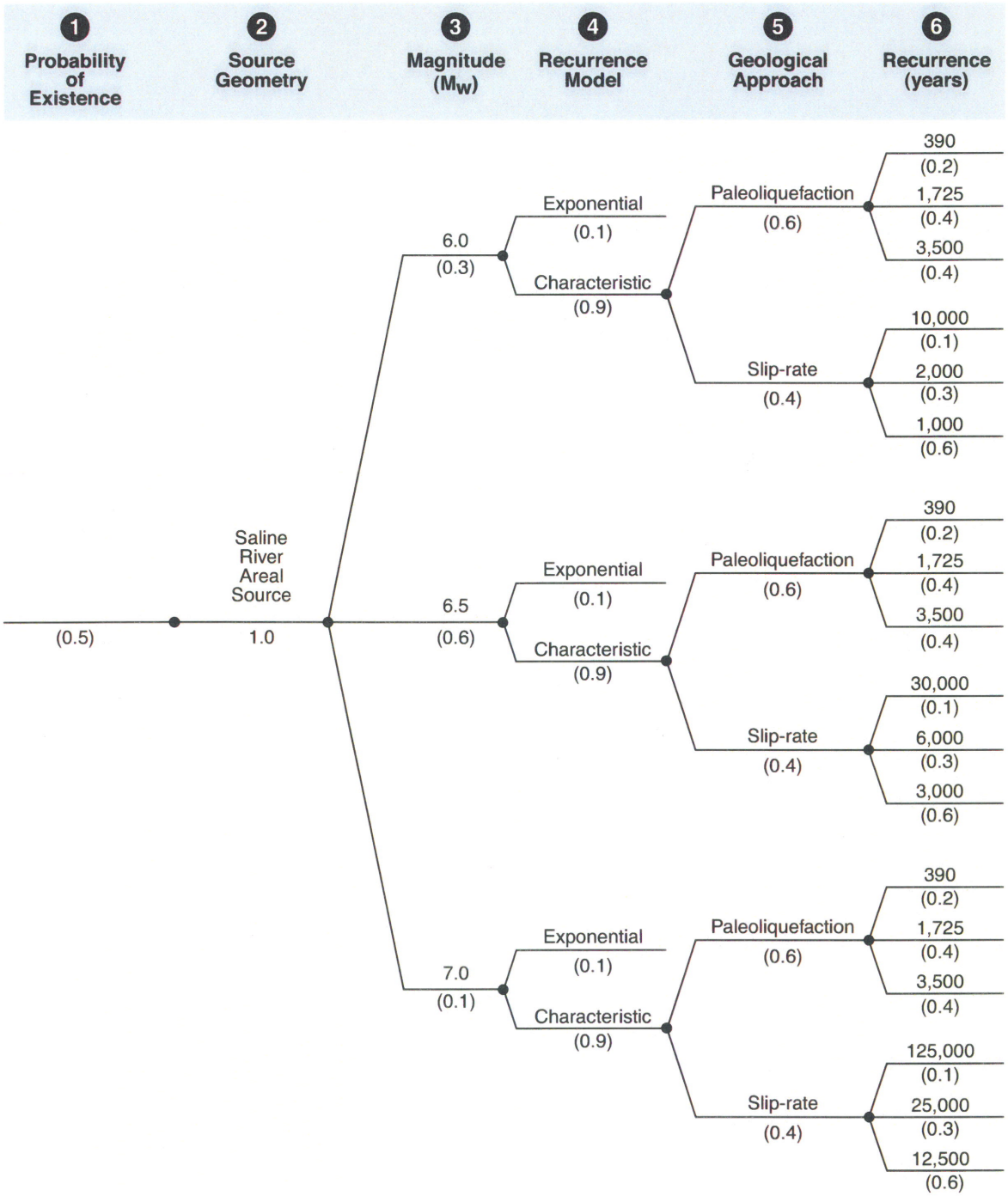
LOGIC TREE
FOR NEW MADRID SEISMIC ZONE

FIGURE 2.5-45 REV. 1



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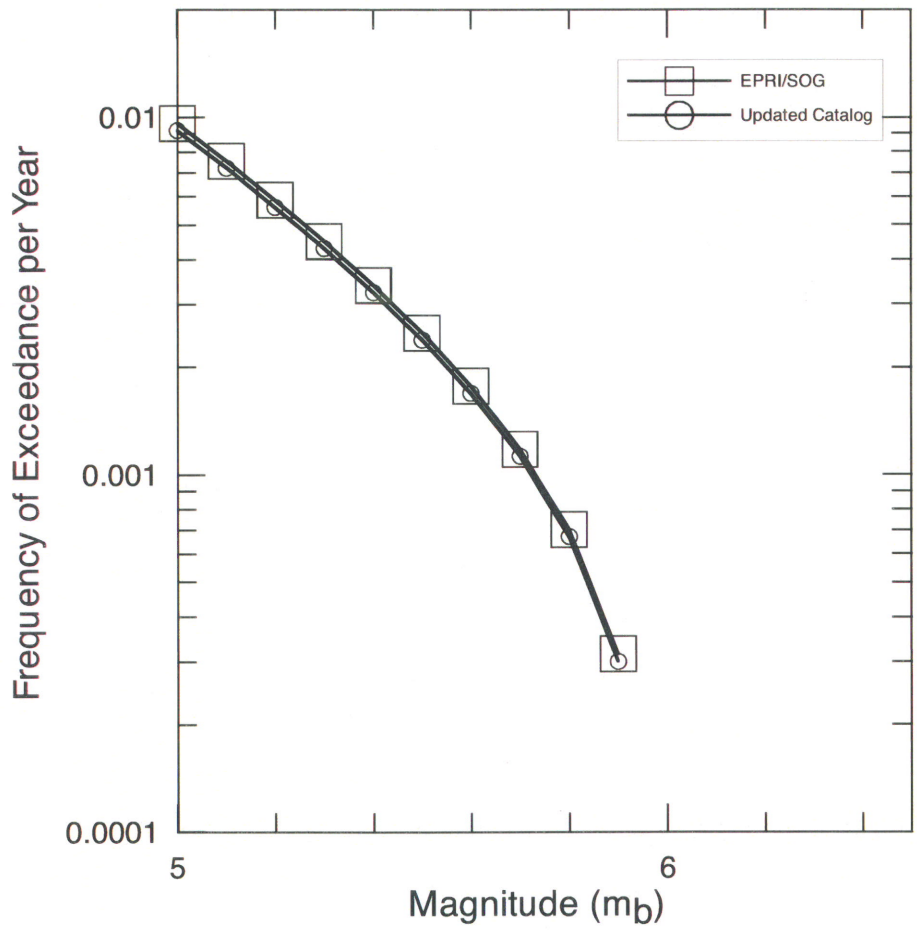
LOGIC TREE
FOR SALINE RIVER SOURCE ZONE

FIGURE 2.5-46 REV. 1



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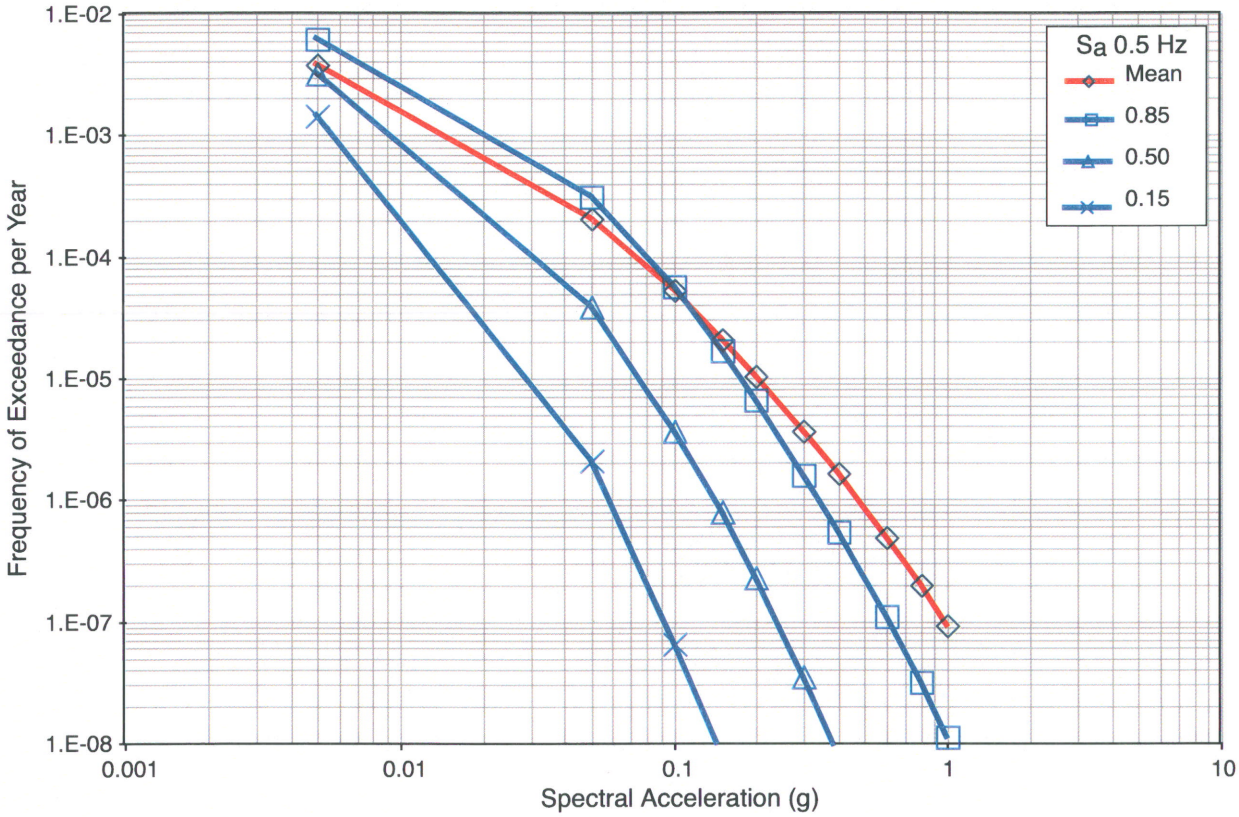
COMPARISON OF THE SENSITIVITY OF ESTIMATES OF EARTHQUAKE OCCURRENCE RATES TO UPDATING THE EPRI EARTHQUAKE CATALOG TO 2001

FIGURE 2.5-47 REV. 1



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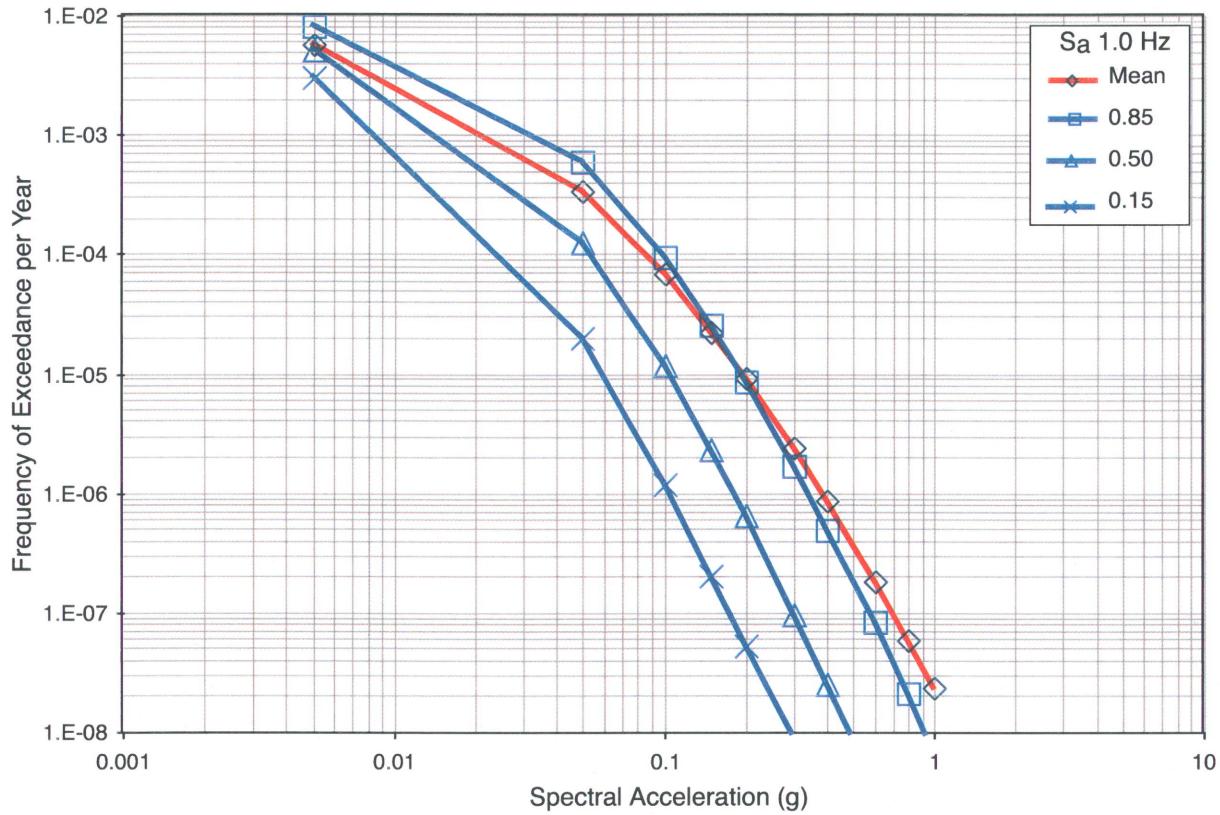
GGNS SEISMIC HAZARD RESULTS FOR
Sa (0.5 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-48 REV. 1



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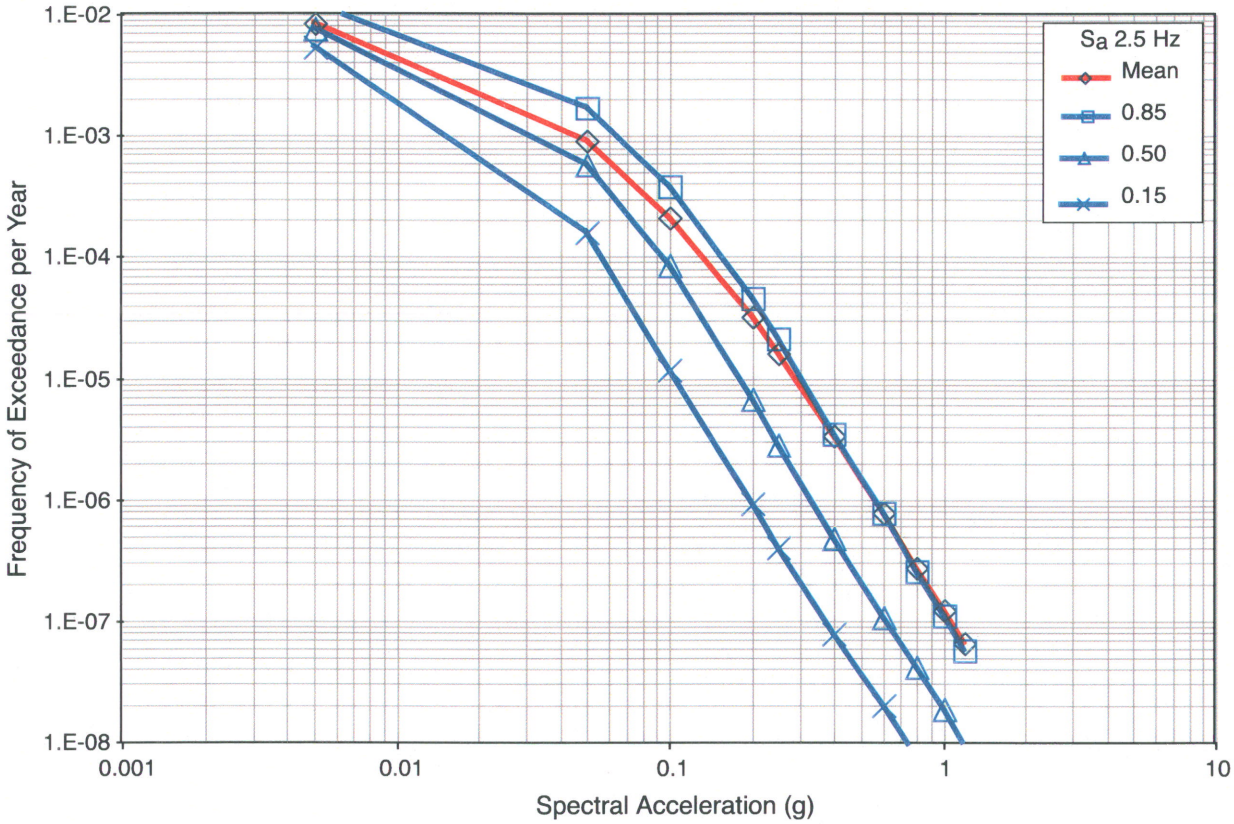
GGNS SEISMIC HAZARD RESULTS FOR
Sa (1 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-49 REV. 1



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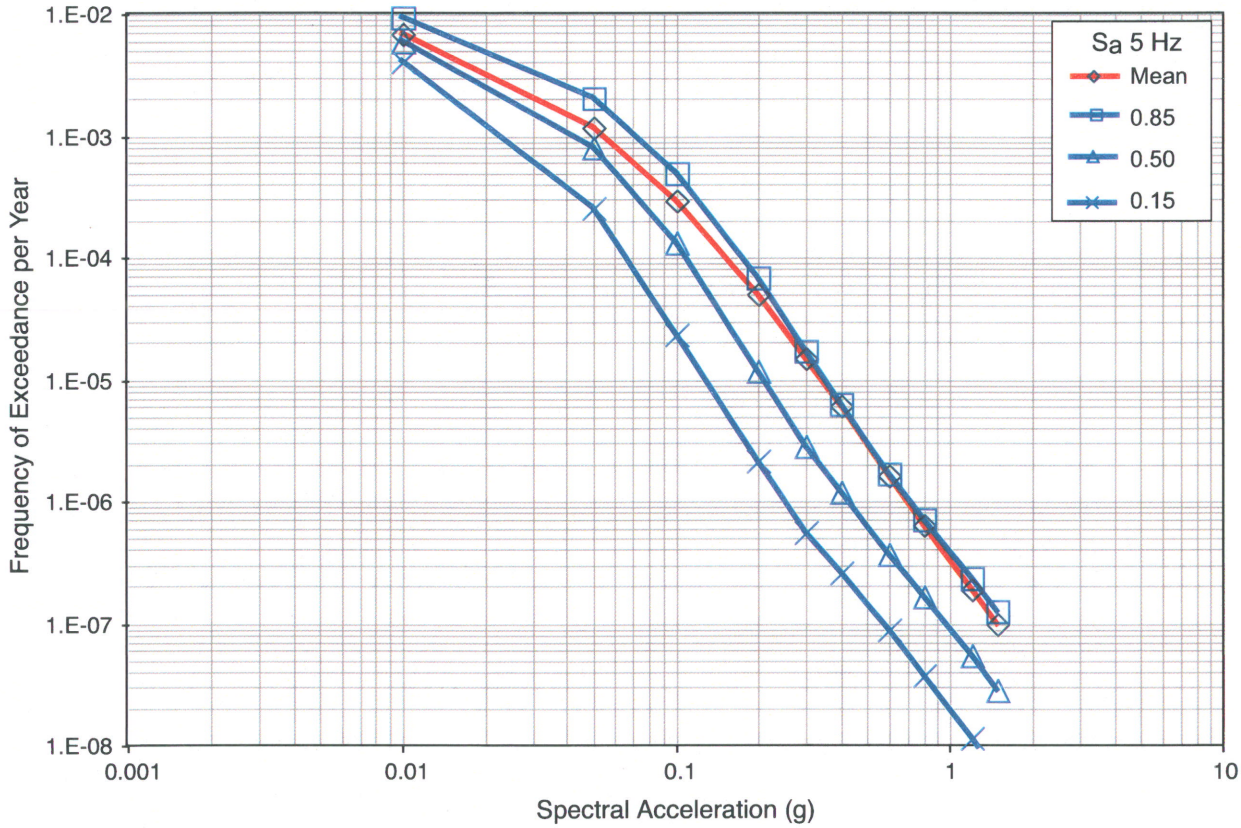
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

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

FIGURE 2.5-50 REV. 1



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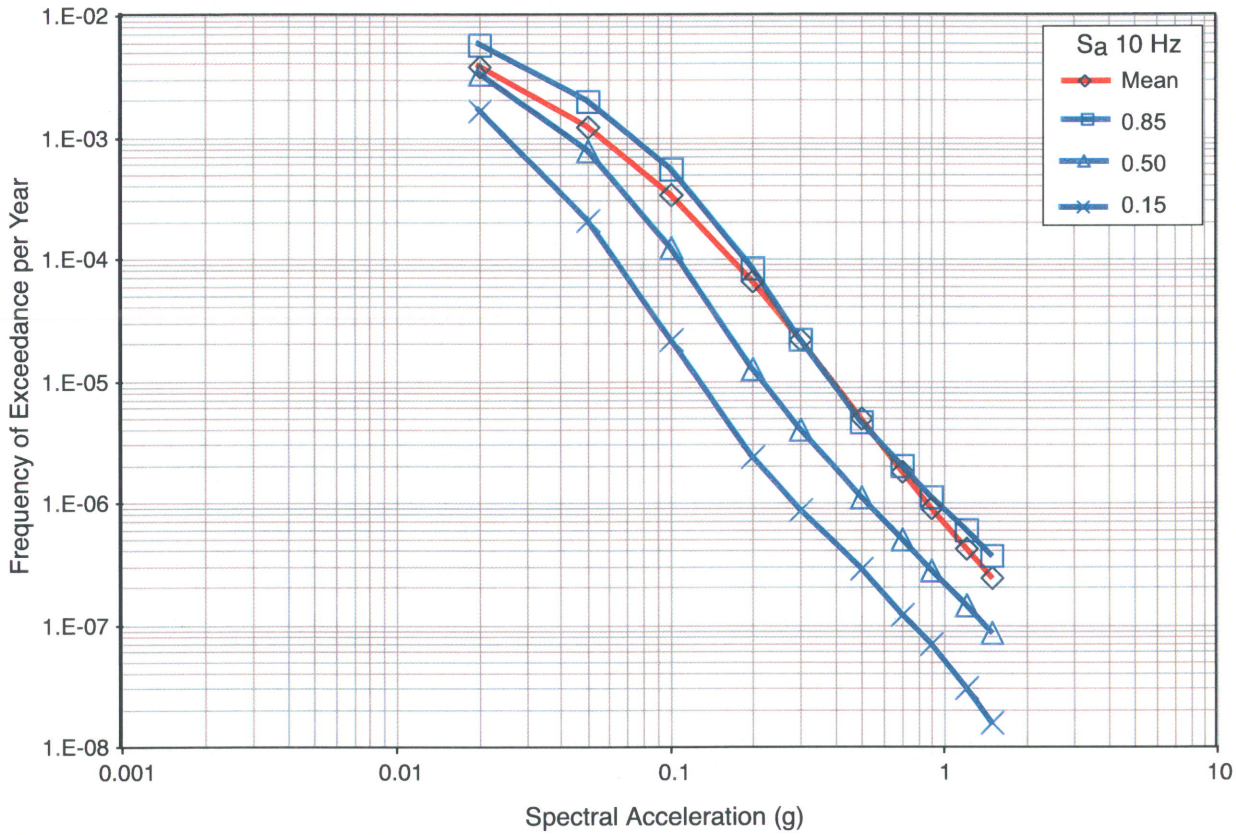
GGNS SEISMIC HAZARD RESULTS FOR
Sa (5 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-51 REV. 1



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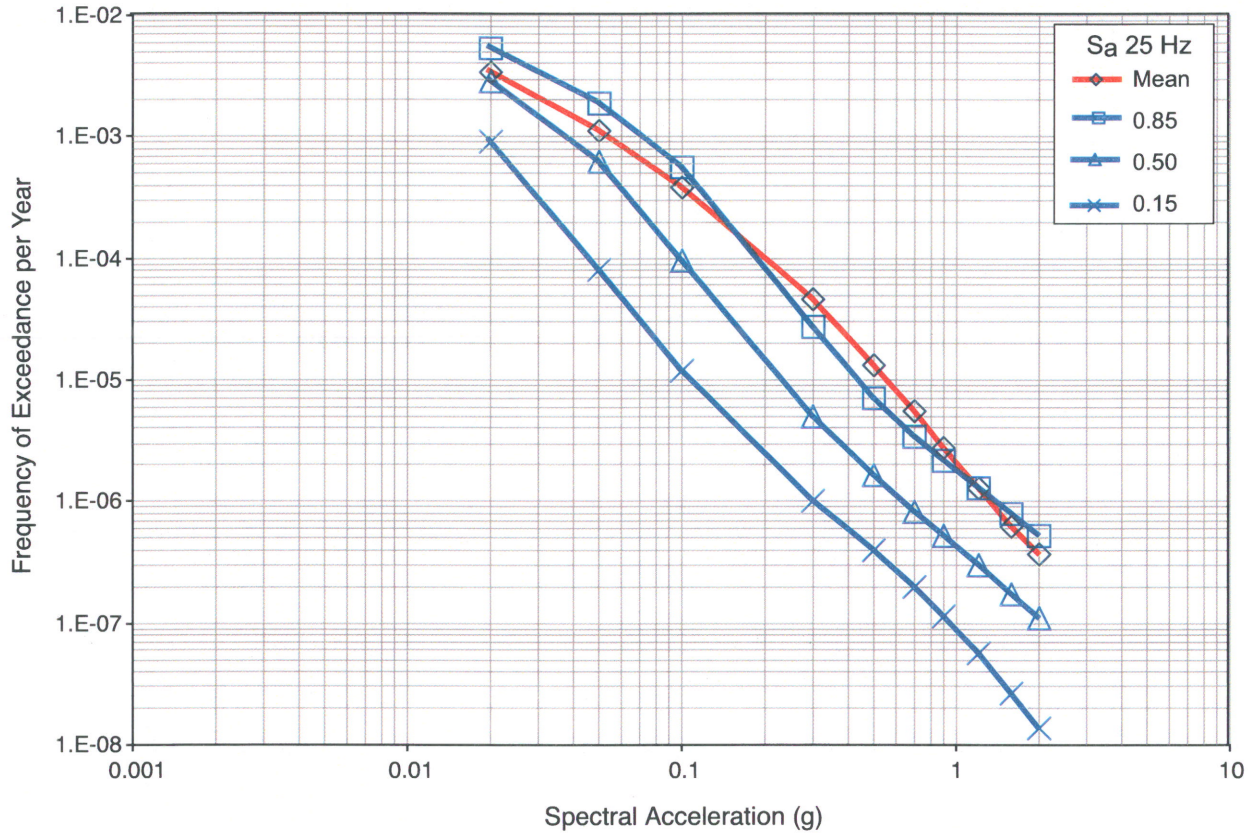
GGNS SEISMIC HAZARD RESULTS FOR
Sa (10 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-52 REV. 1



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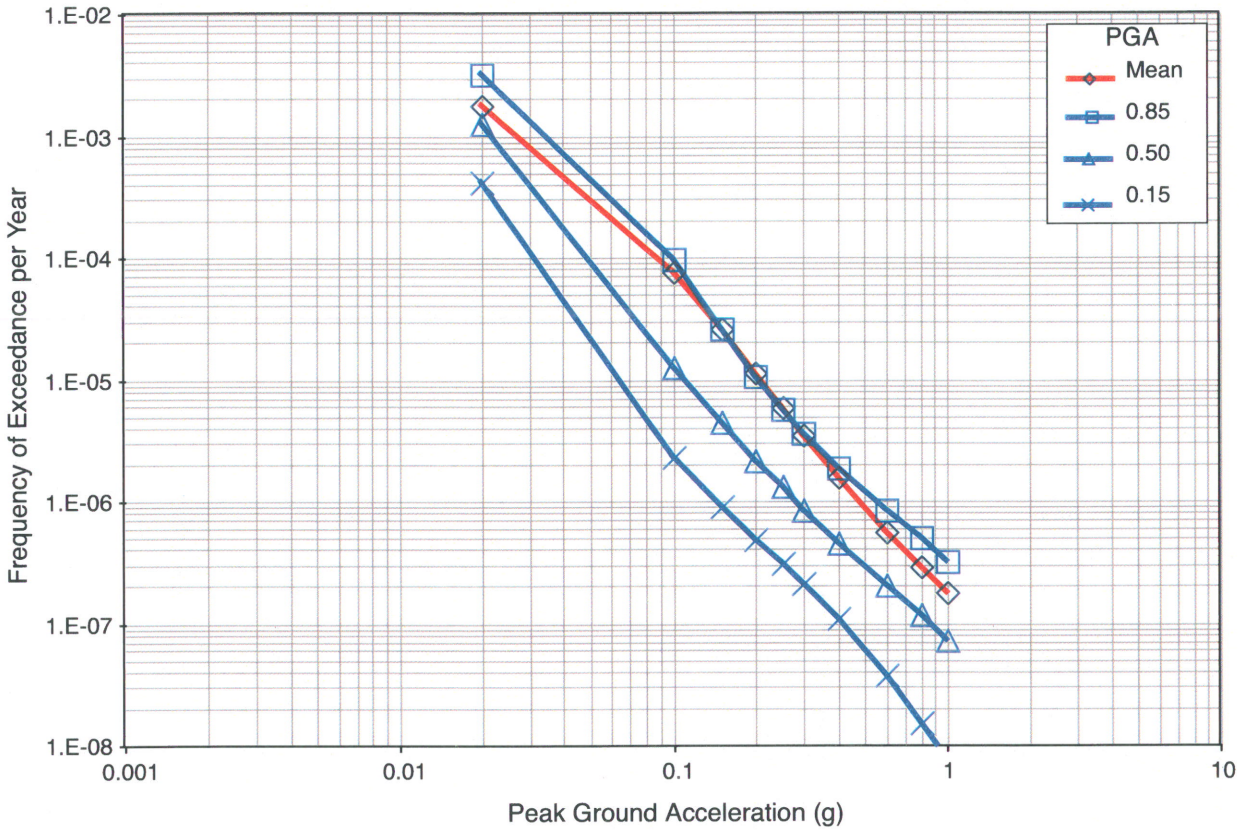
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

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

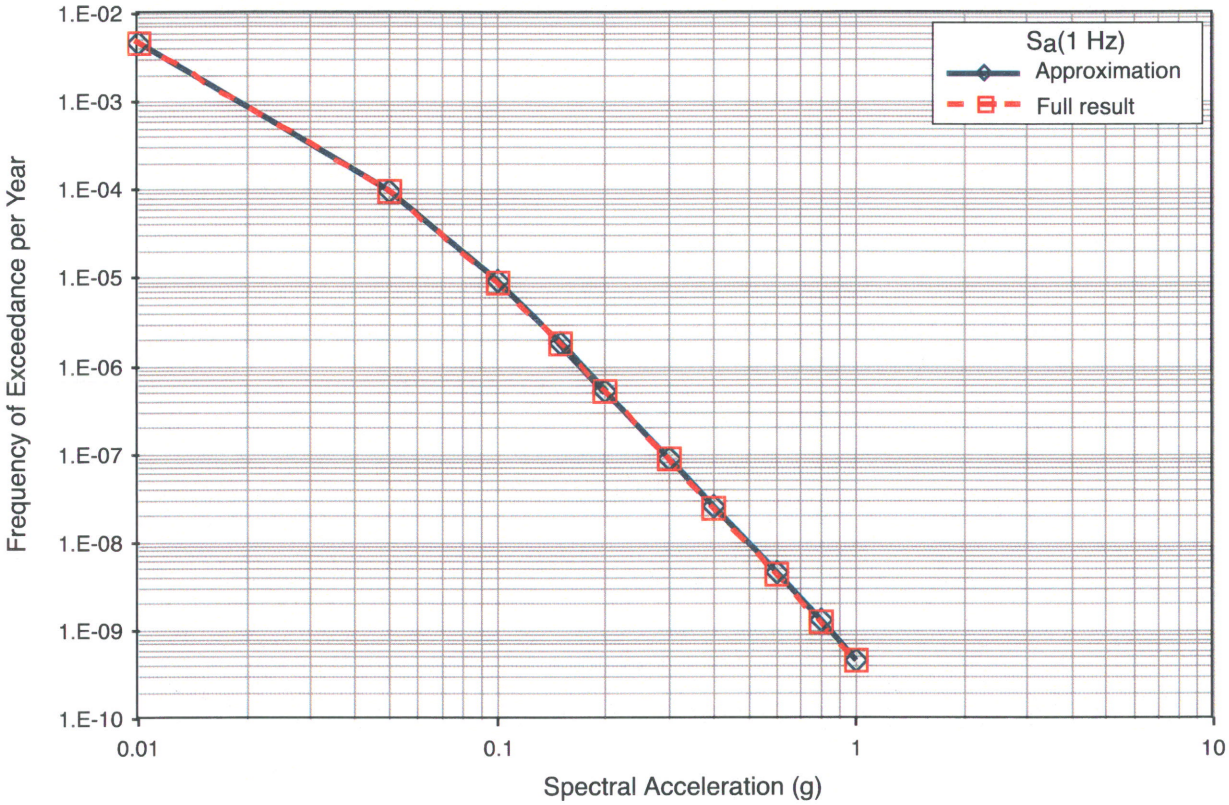

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ILLUSTRATION OF THE SENSITIVITY OF THE GGNS MEDIAN SEISMIC HAZARD RESULTS FOR S_a 1 Hz TO USING A REDUCED NUMBER OF SEISMICITY OPTIONS FOR THE ORIGINAL EPRI SOG SEISMIC SOURCES

FIGURE 2.5-55 REV. 1

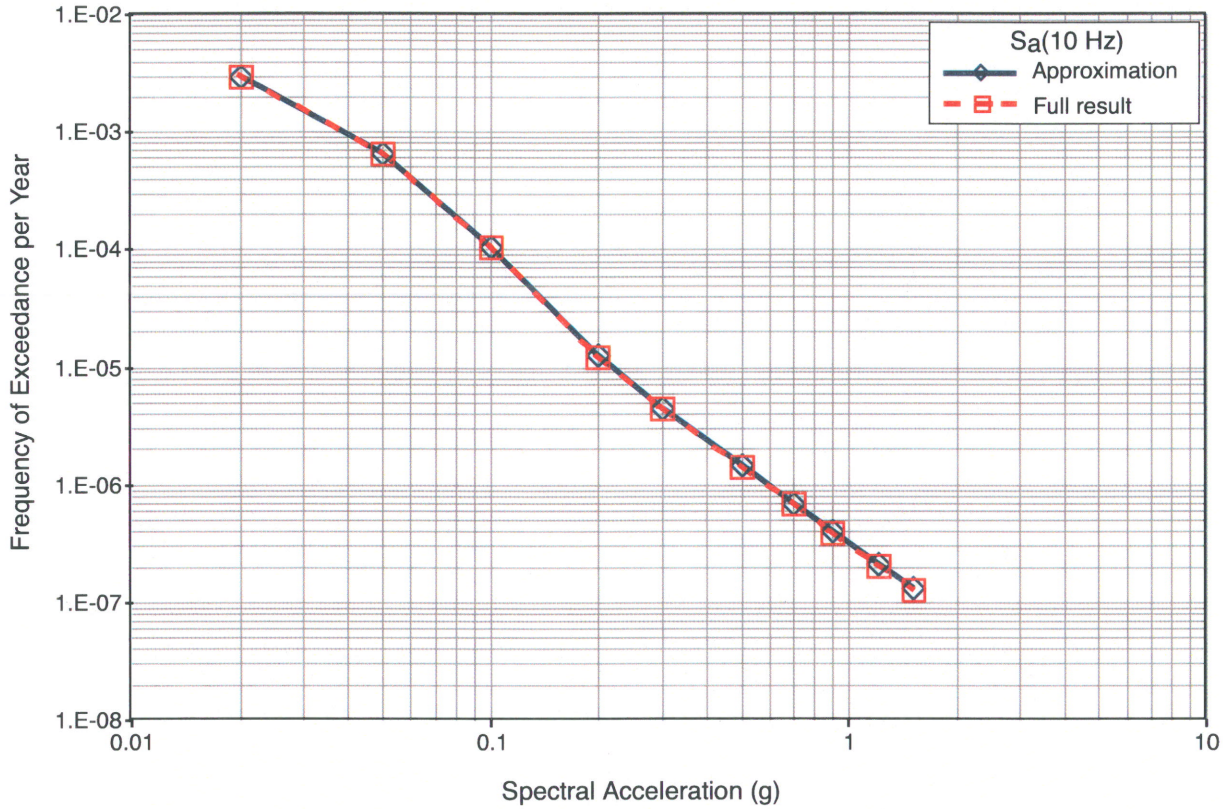

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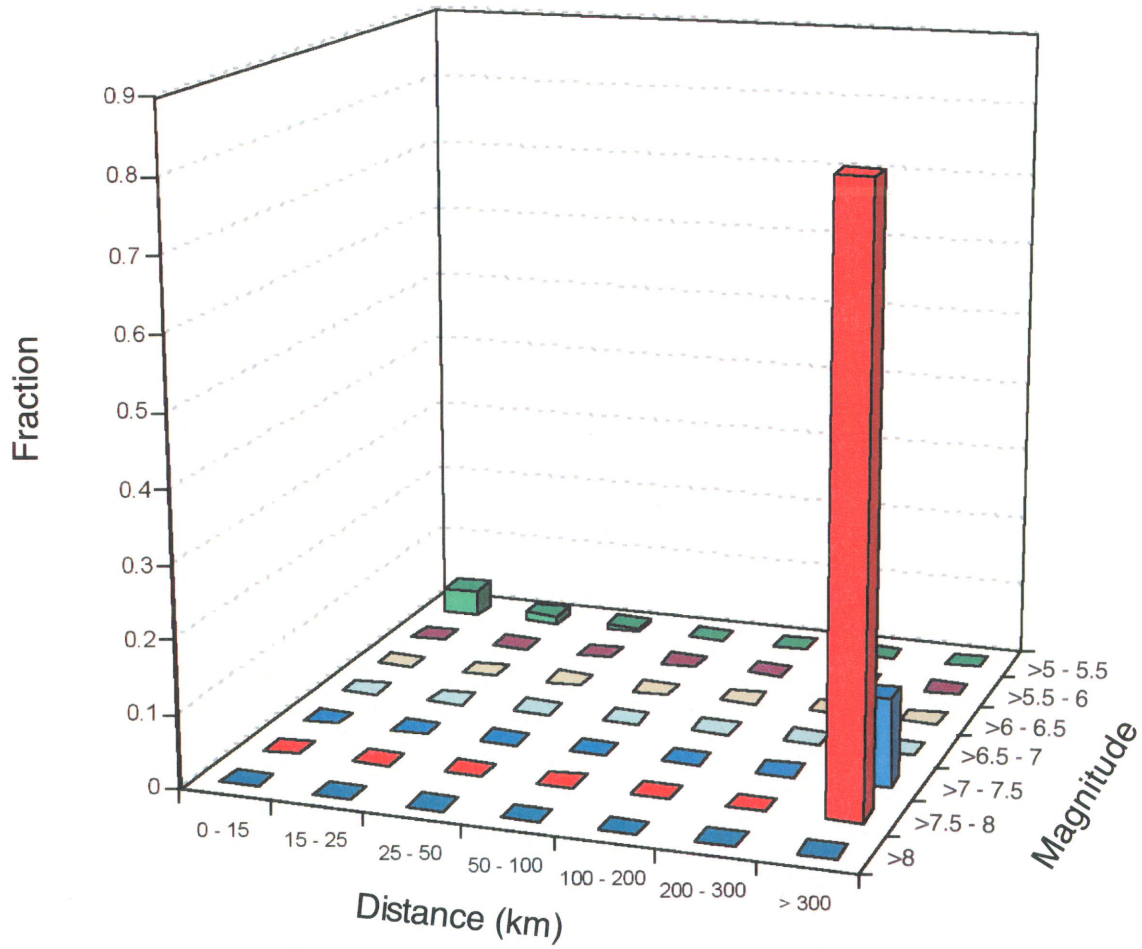
ILLUSTRATION OF THE SENSITIVITY OF THE GGNS MEDIAN SEISMIC HAZARD RESULTS FOR S_a 10 Hz TO USING A REDUCED NUMBER OF SEISMICITY OPTIONS FOR THE ORIGINAL EPRI SOG SEISMIC SOURCES

FIGURE 2.5-56 REV. 1

Low Frequency Deaggregation



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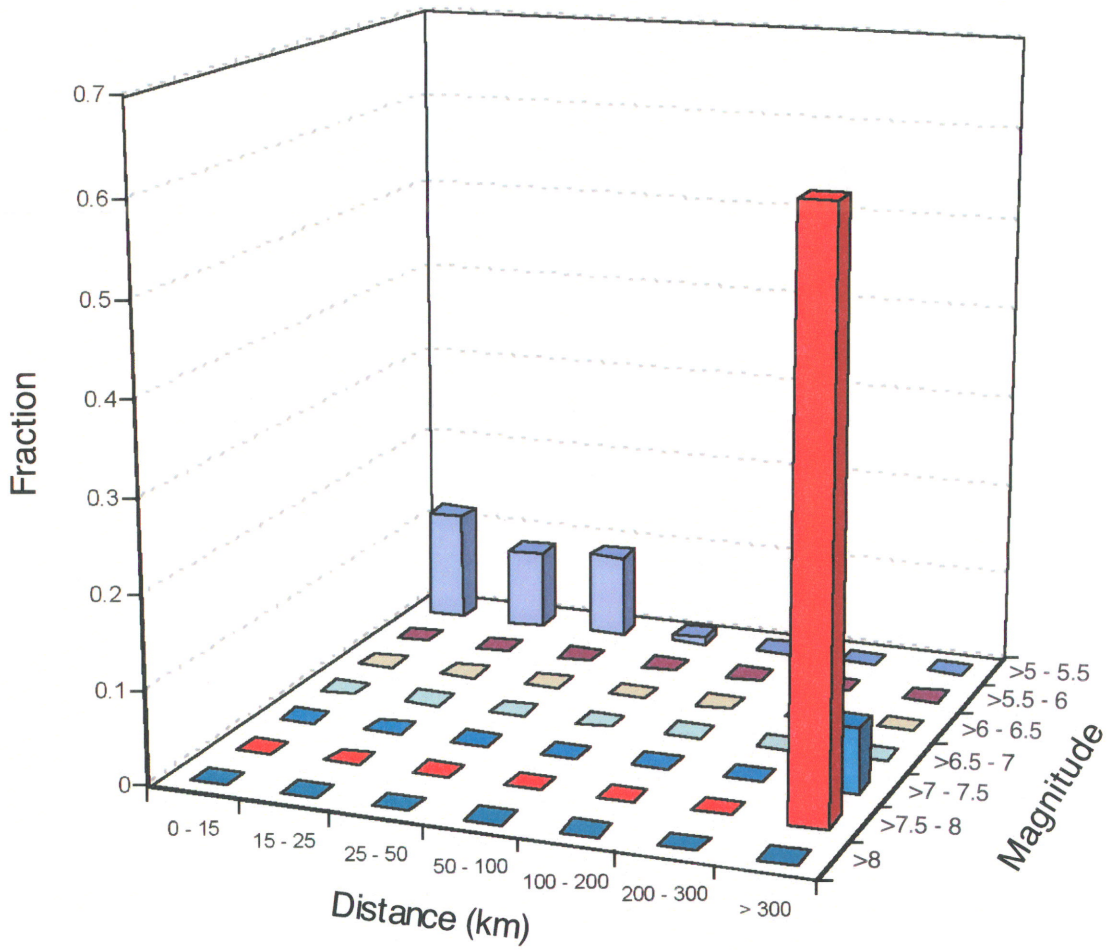
DEAGGREGATION FOR LOW FREQUENCY (S_a(1-2.5Hz)) GROUND MOTIONS AT THE GGNS ESP SITE

FIGURE 2.5-57 REV. 1

High Frequency Deaggregation



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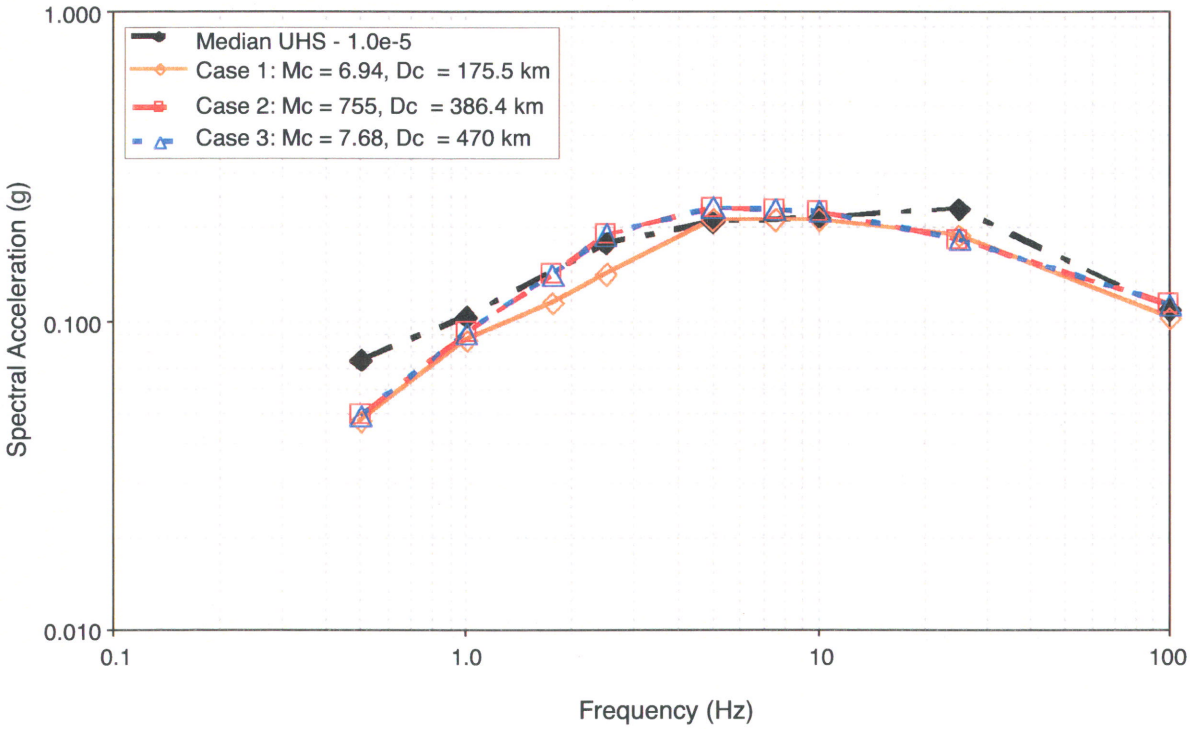
DEAGGREGATION FOR HIGH FREQUENCY (S_a(5-10Hz)) GROUND MOTIONS AND AT THE GGNS ESP SITE

FIGURE 2.5-58 REV. 1



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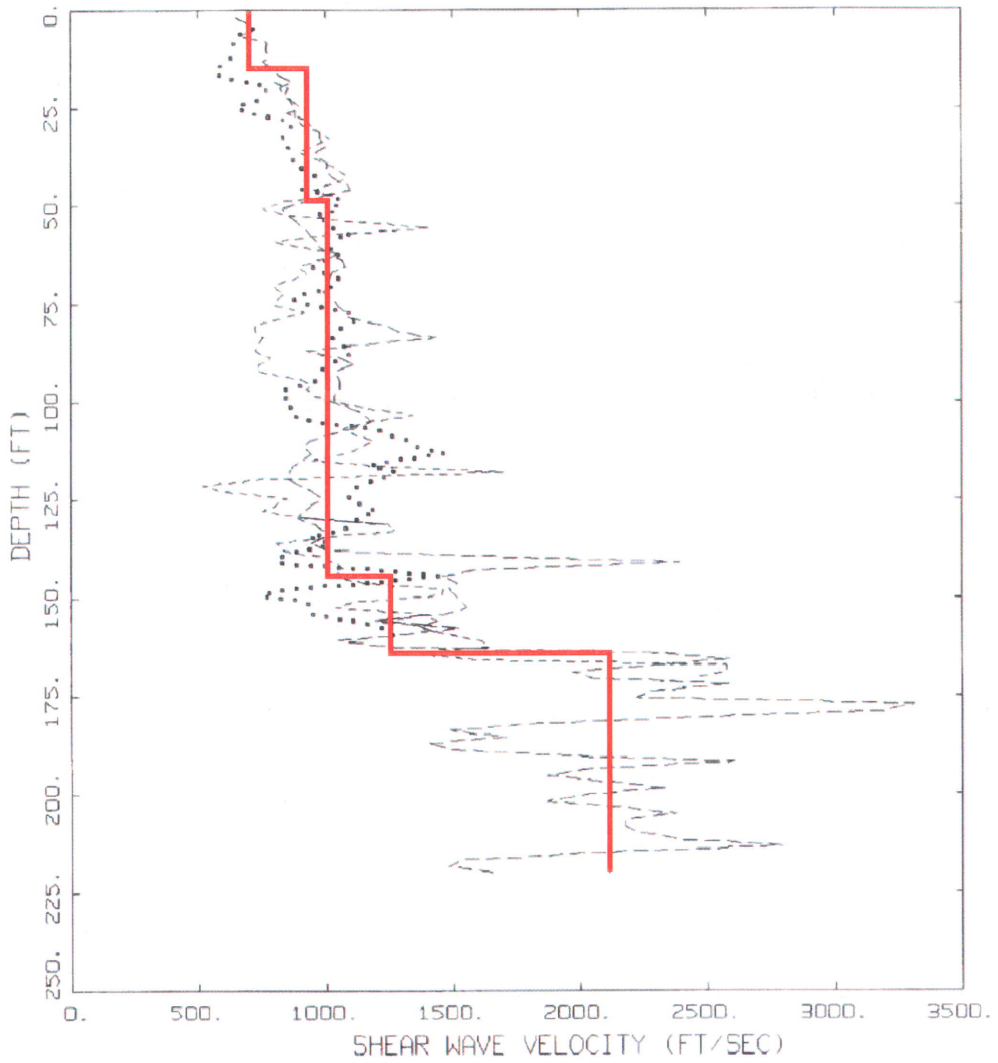
COMPARISON OF THE GGNS 10^{-5} MEDIAN UNIFORM HAZARD RESPONSE SPECTRUM AND THE MEDIAN RESPONSE SPECTRA ASSOCIATED WITH THE CONTROLLING EARTHQUAKES

FIGURE 2.5-59 REV. 1



GRAND GULF
SITE SPECIFIC PROFILES

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

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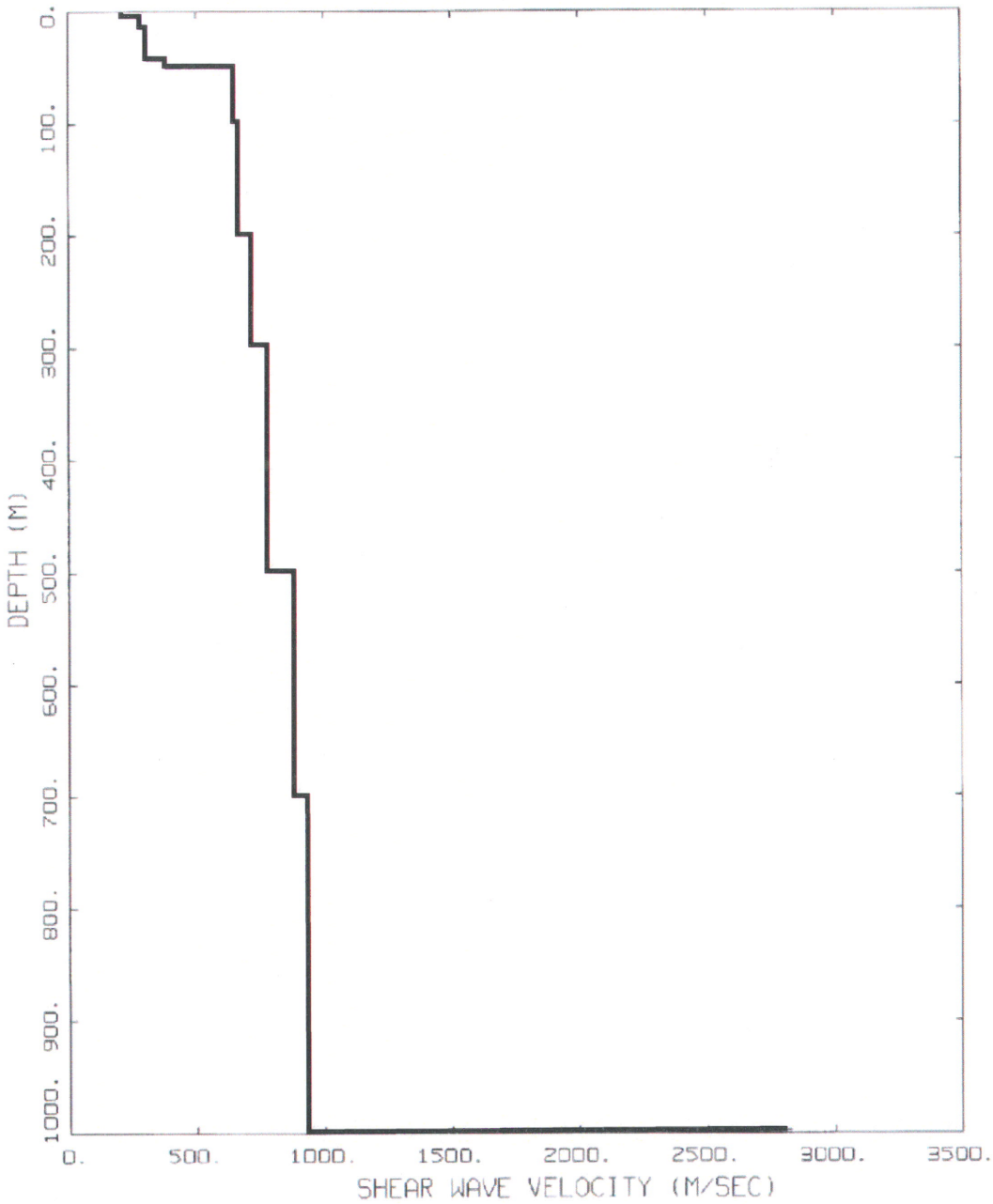
BASE CASE SHEAR-WAVE VELOCITY PROFILE
AND SUSPENSION LOG MEASUREMENTS

FIGURE 2.5-60 REV. 1



GRAND GULF
SITE SPECIFIC PROFILE

LEGEND
BASE CASE MODEL TO 1 KM

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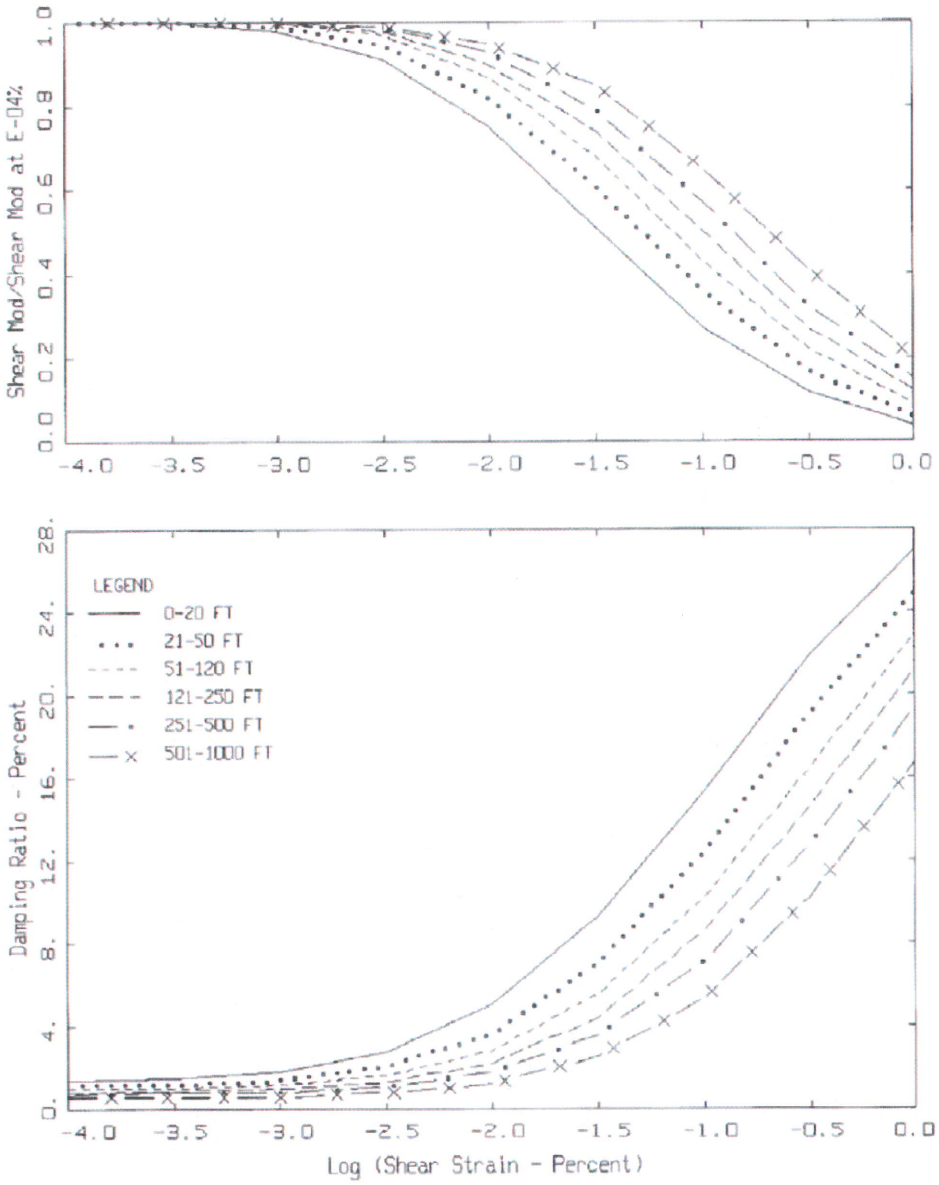
BASE CASE SHEAR-WAVE VELOCITY PROFILE
EXTENDED TO A DEPTH OF 1,000M

FIGURE 2.5-61 REV. 1



MODULUS REDUCTION AND DAMPING CURVES
EPRI(1993)

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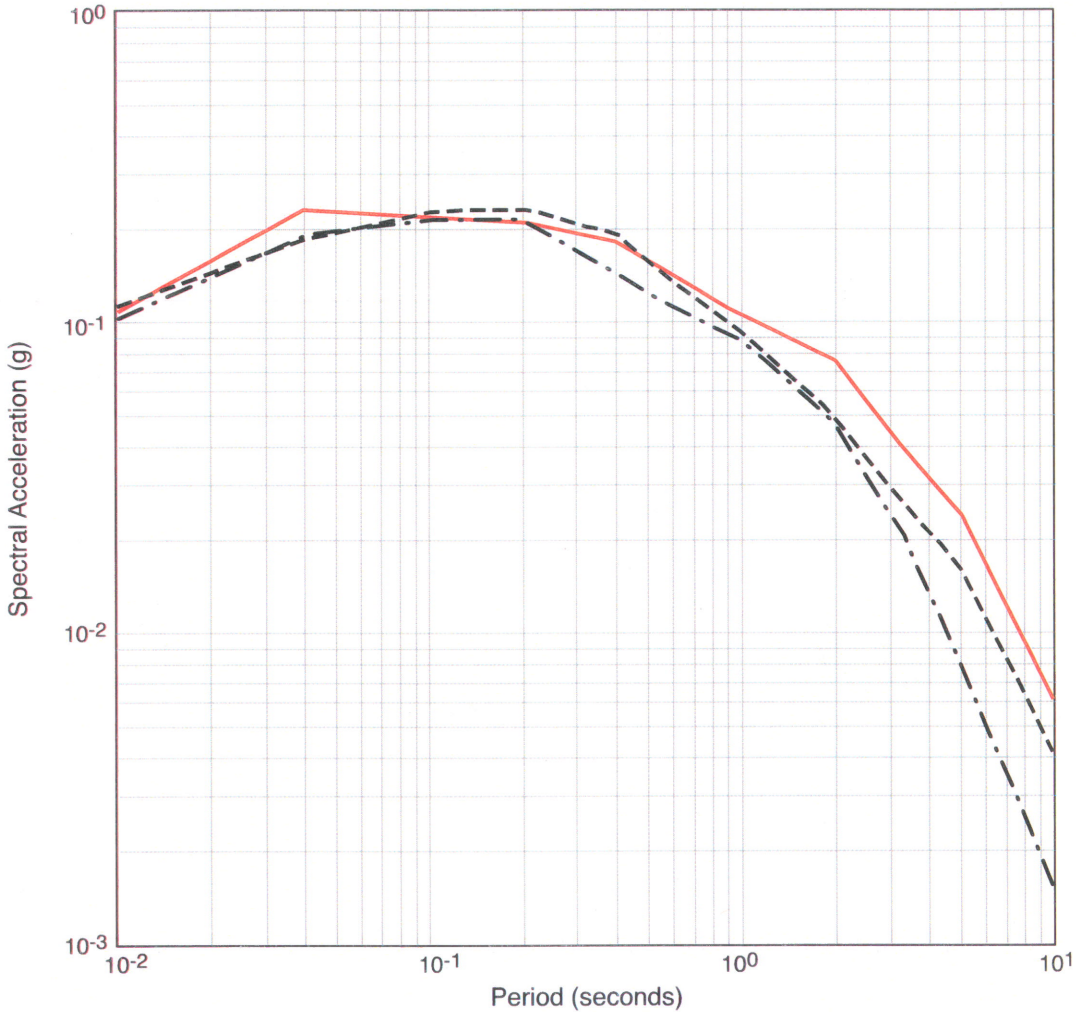
COHESIONLESS SOIL MODULUS
REDUCTION AND DAMPING CURVES
(EPRI, 1993) ADOPTED FOR THE SITE

FIGURE 2.5-62 REV. 1

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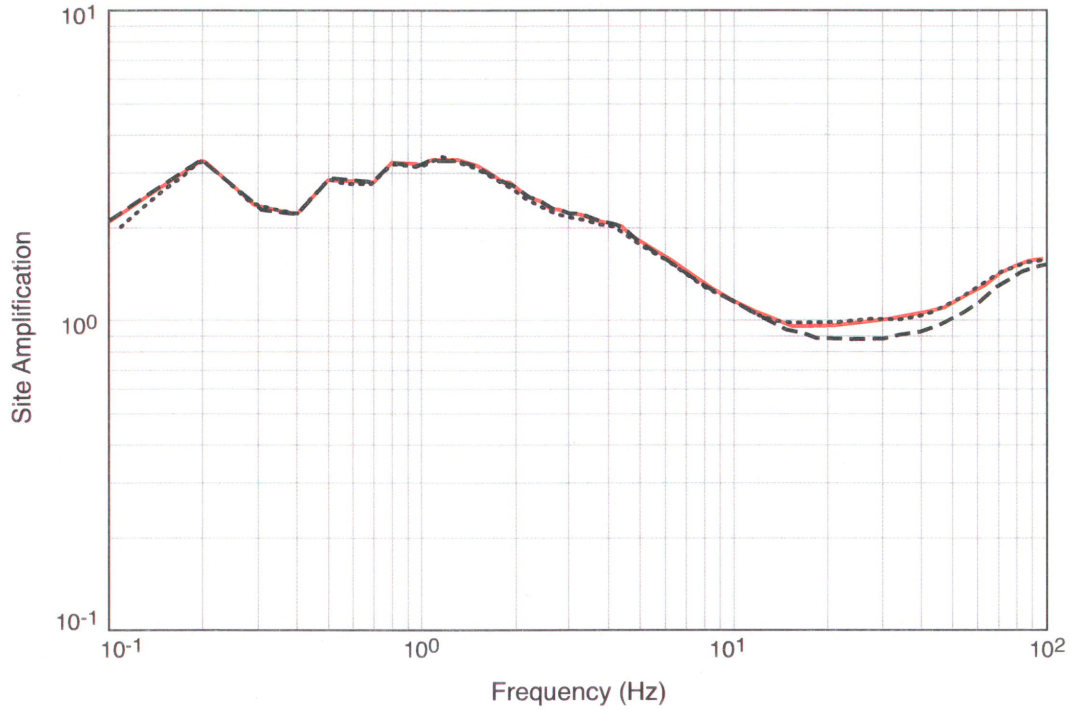
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

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

FIGURE 2.5-63 REV. 1

TOP OF LOESS MEAN AMPLIFICATION



Explanation

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

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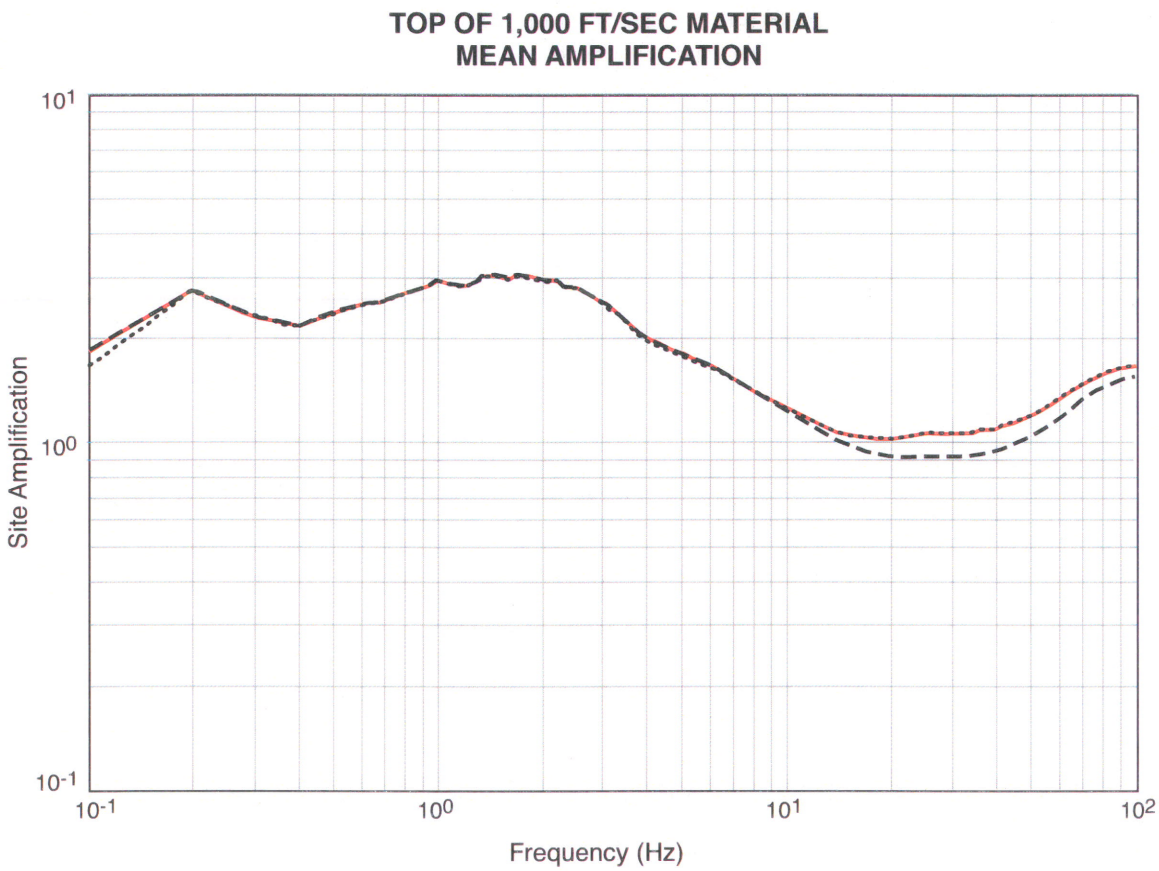
MEAN TRANSFER FUNCTIONS CORRESPONDING TO 1 TO 2 HZ AND 5 TO 10 HZ SCALED SPECTRA (FIGURE 2.5-63) AND ENVELOPE: TOP OF LOESS

FIGURE 2.5-64 REV. 1



Explanation

Envelope

Mean 1 - 2 Hz

Mean 5 - 10 Hz

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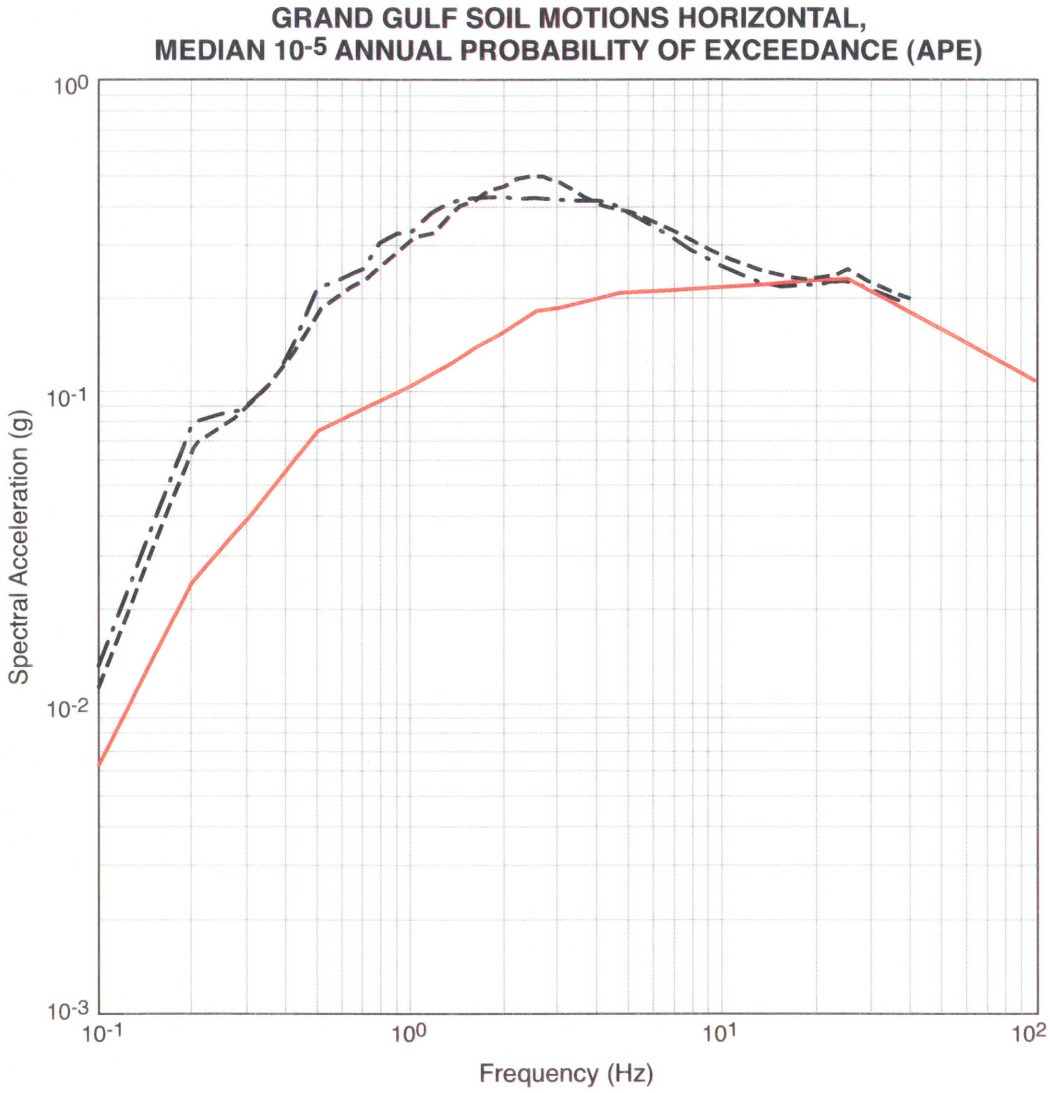
MEAN TRANSFER FUNCTIONS CORRESPONDING TO 1 TO 2 HZ SCALED SPECTRA (FIGURE 2.5-63) AND ENVELOPE: TOP OF MATERIAL WITH 1,000 FT/SEC SHEAR-WAVE VELOCITY, DEPTH 50 FT (FIGURE 2.5-60)

FIGURE 2.5-65 REV. 1



Explanation

Rock UHS; PGA = 0.113g

1,000 ft/sec soil surface, 0.200g

Top of loess, 0.192g

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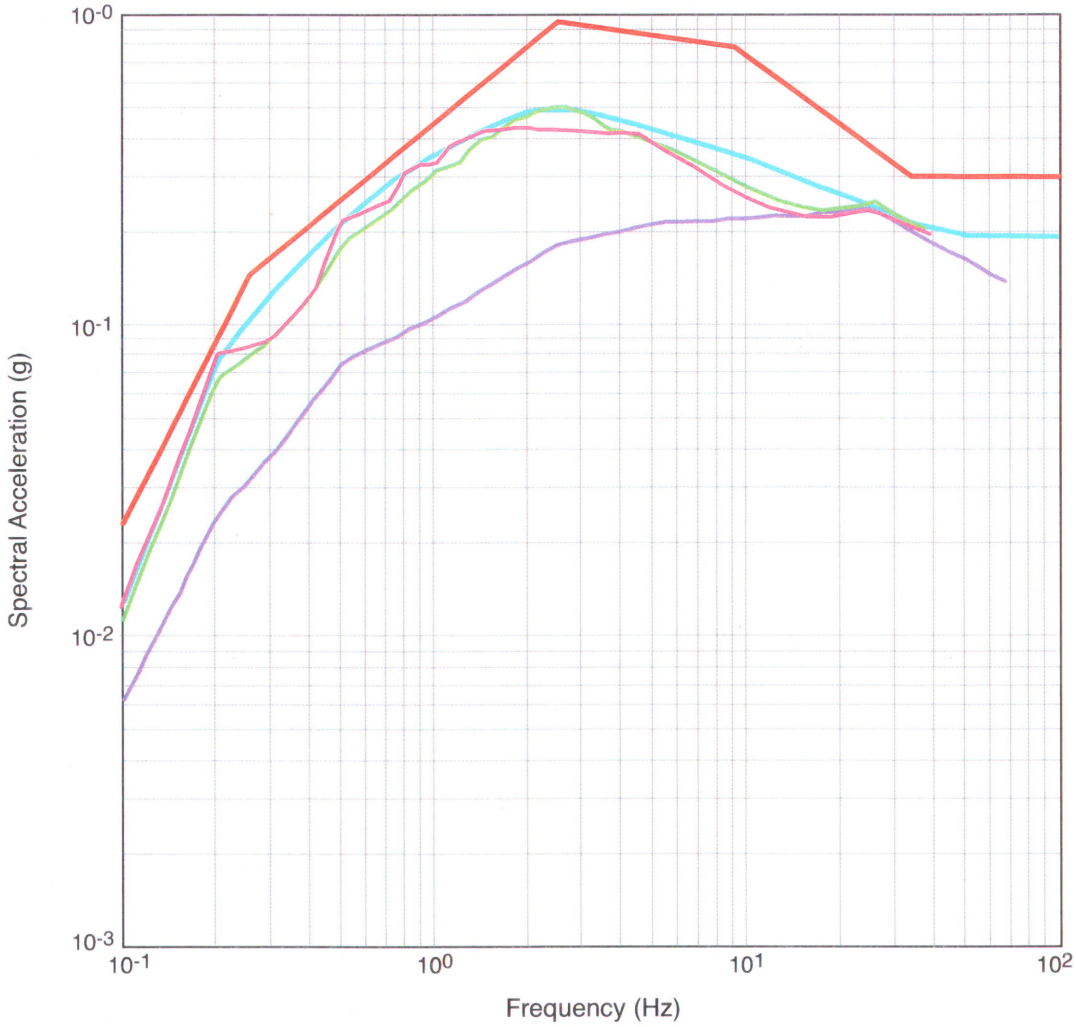
HARD ROCK UNIFORM HAZARD RESPONSE SPECTRUM (UHS) AND CORRESPONDING SOIL MOTIONS: DASH-DOTTED, TOP OF LOESS; DASHED, TOP OF MATERIAL WITH 1,000 FT/SEC SHEAR-WAVE VELOCITY, 50 FT DEPTH (FIGURE 2.5-60)

FIGURE 2.5-66 REV. 1

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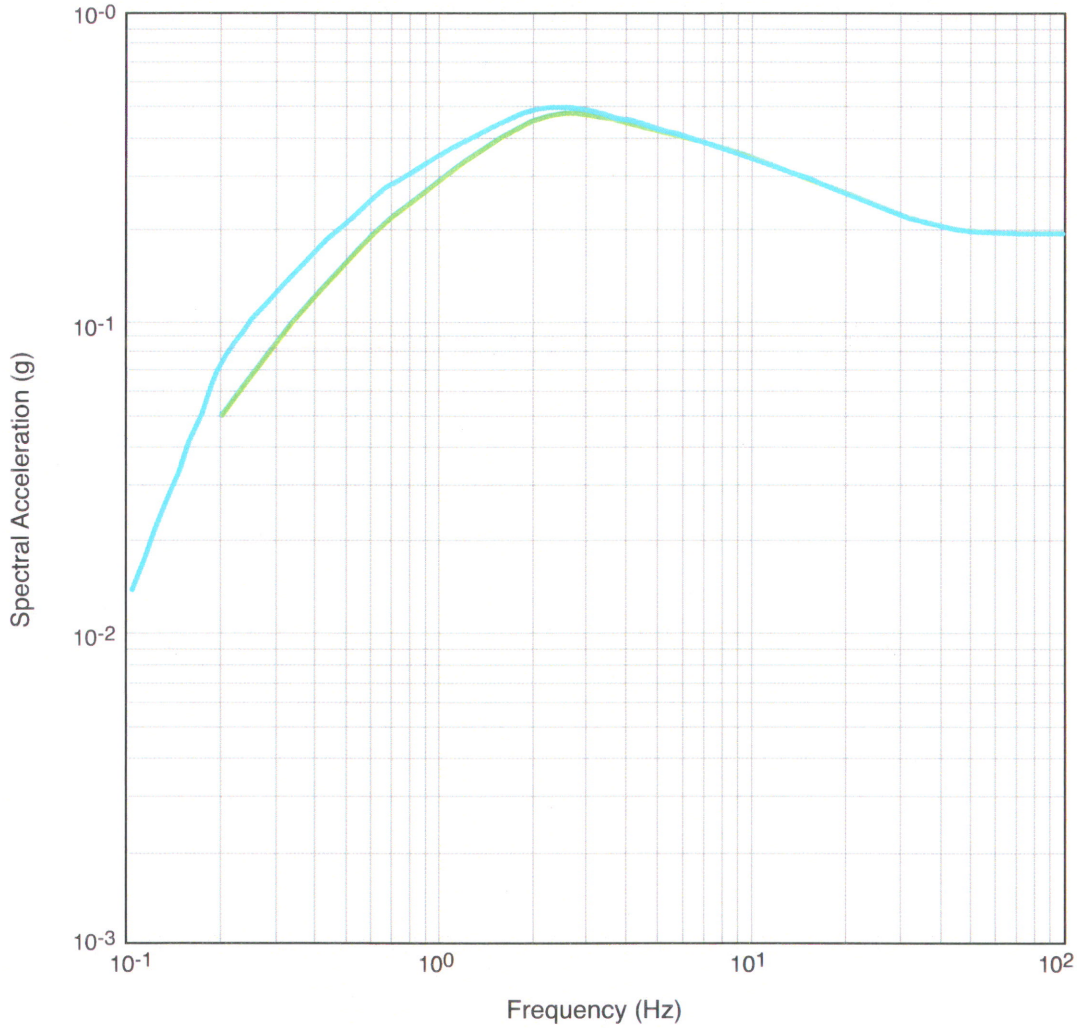
HORIZONTAL SOIL DESIGN GROUND MOTION (BLUE) AS ENVELOPE OF TOP OF LOESS MOTION AND MOTION WITH TOP 50 FT OF LOESS REMOVED (GREEN). NRC REGULATORY GUIDE 1.60 SPECTRUM SCALED TO 0.3G (RED)

FIGURE 2.5-67 REV. 1

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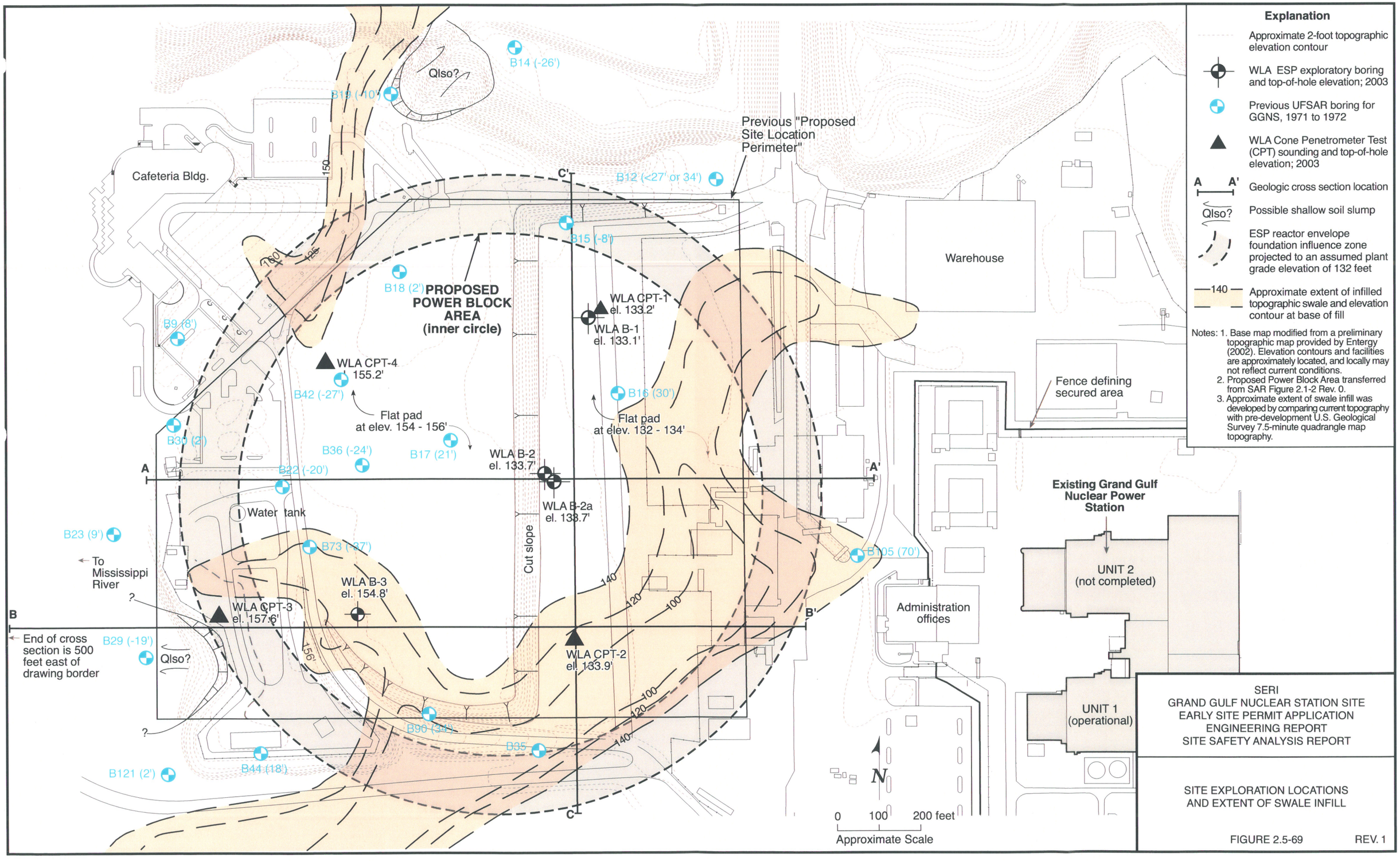
VERTICAL SOIL DESIGN MOTION BASED ON NRC REGULATORY GUIDE 1.60 V/H RATIOS

FIGURE 2.5-68 REV. 1


Explanation
Approximate 2-foot topographic elevation contour
WLA ESP exploratory boring and top-of-hole elevation; 2003
Previous UFSAR boring for GGNS, 1971 to 1972
WLA Cone Penetrometer Test (CPT) sounding and top-of-hole elevation; 2003
A A'
Geologic cross section location
Qlso?
Possible shallow soil slump
ESP reactor envelope foundation influence zone projected to an assumed plant grade elevation of 132 feet
140
Approximate extent of infilled topographic swale and elevation contour at base of fill
Notes: 1. Base map modified from a preliminary topographic map provided by Entergy (2002). Elevation contours and facilities are approximately located, and locally may not reflect current conditions.
2. Proposed Power Block Area transferred from SAR Figure 2.1-2 Rev. 0.
3. Approximate extent of swale infill was developed by comparing current topography with pre-development U.S. Geological Survey 7.5-minute quadrangle map topography.
Cafeteria Bldg.
Qlso?
B14 (-26')
B19 (-10')
Previous "Proposed Site Location Perimeter"
C'
B12 (<27' or 34')
B15 (-8')
Warehouse
B18 (2')
PROPOSED POWER BLOCK AREA (inner circle)
WLA CPT-1 el. 133.2'
WLA B-1 el. 133.1'
B9 (8')
WLA CPT-4 155.2'
B42 (-27')
B16 (30')
Fence defining secured area
Flat pad at elev. 154 - 156'
Flat pad at elev. 132 - 134'
B30 (2')
B36 (-24')
B17 (21')
WLA B-2 el. 133.7'
A
A'
B22 (-20')
WLA B-2a el. 133.7'
Existing Grand Gulf Nuclear Power Station
Water tank
B23 (9')
B73 (-37')
Cut slope
B105 (70')
To Mississippi River
WLA B-3 el. 154.8'
UNIT 2 (not completed)
B
B'
WLA CPT-3 el. 157.6'
Administration offices
End of cross section is 500 feet east of drawing border
B29 (-19')
Qlso?
WLA CPT-2 el. 133.9'
UNIT 1 (operational)
B90 (34')
B35
B44 (18')
B121 (2')
C
N
0 100 200 feet
Approximate Scale
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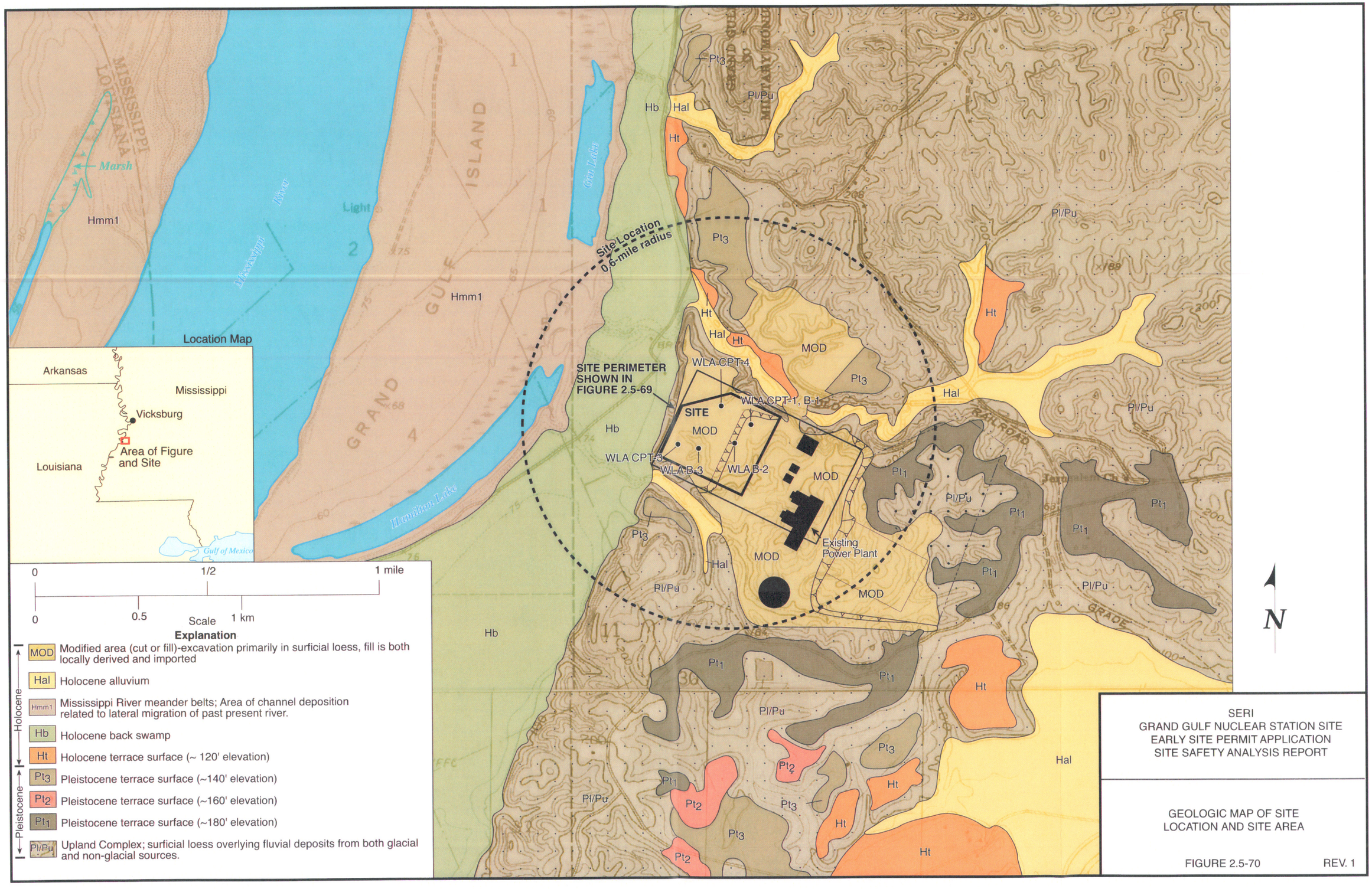
ENGINEERING REPORT
SITE SAFETY ANALYSIS REPORT
SITE EXPLORATION LOCATIONS AND EXTENT OF SWALE INFILL
FIGURE 2.5-69
REV. 1



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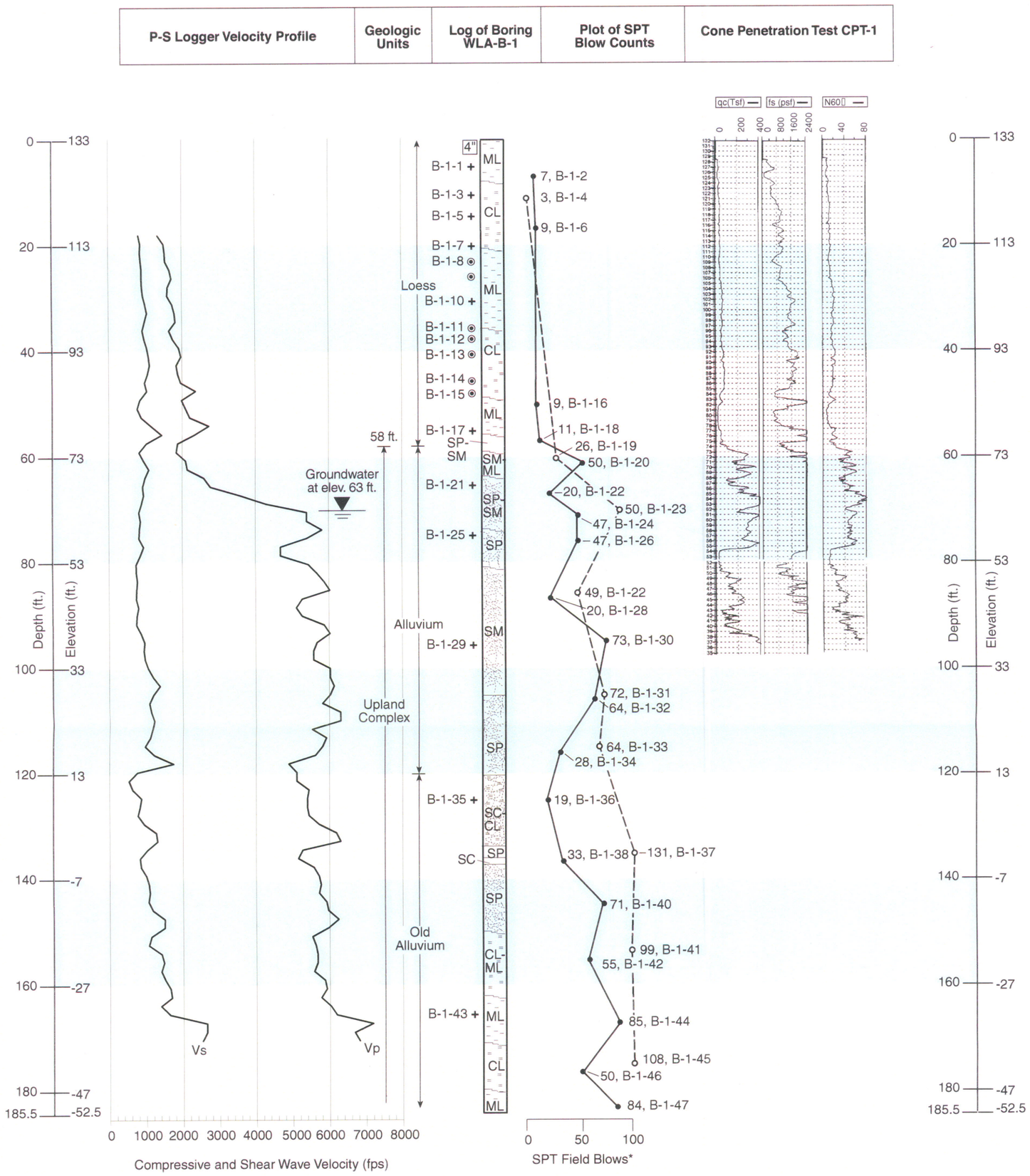
GEOLOGIC MAP OF SITE LOCATION AND SITE AREA

FIGURE 2.5-70 REV. 1



Notes:
1. Downhole geophysics in uncased hole performed by T. Martin of Geovision.
2. Groundwater level interpreted from geophysical log.
3. Vs = Shear Wave Velocity
   Vp = Compressional Wave Velocity
4. CPT-1 is located approximately 10 feet northeast of B-1.
5. Elevation of ground surface at boring is 133.2 feet.
6. Boring started on July 24, and completed July 30, 2002.
7. 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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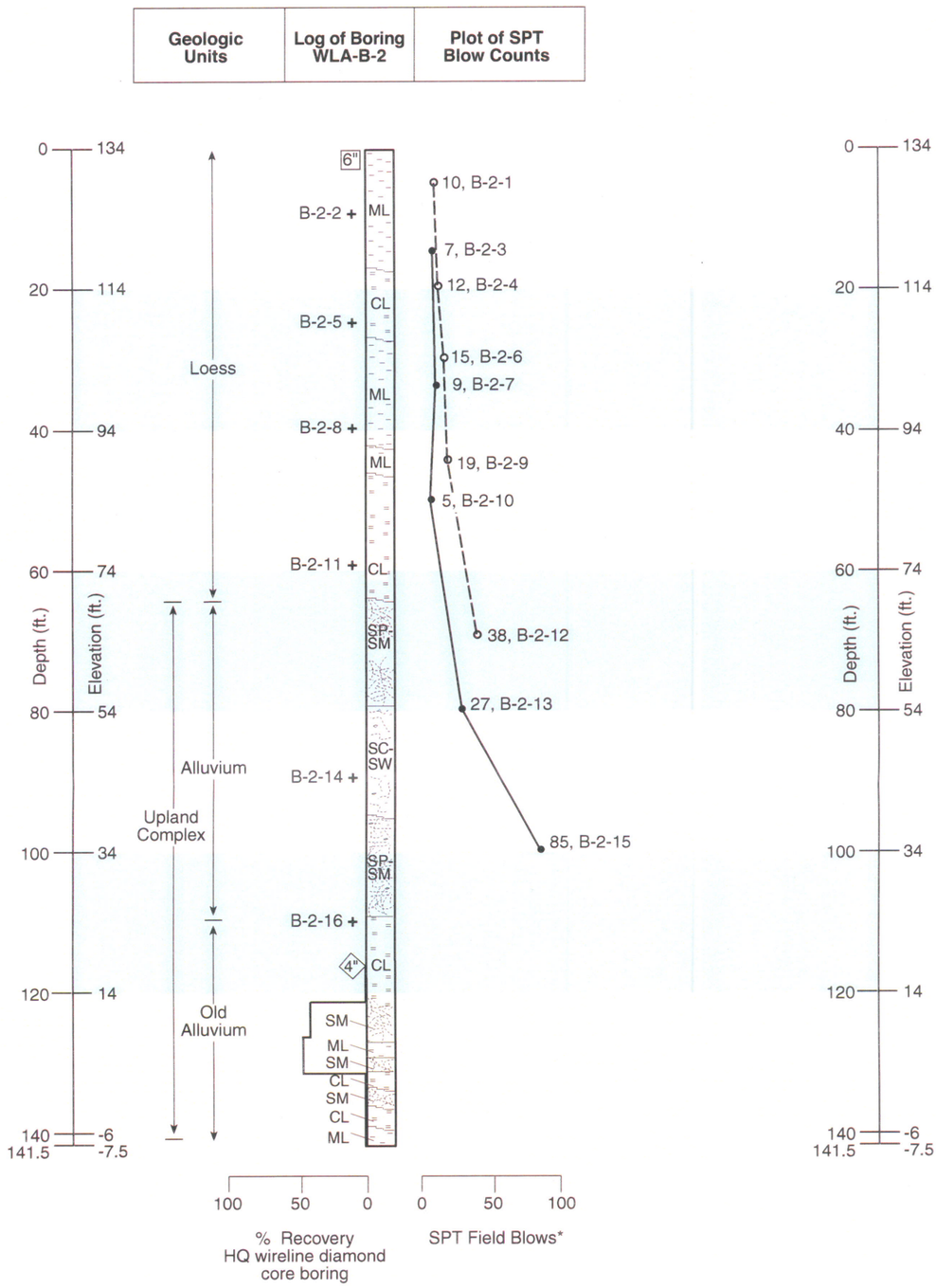
BORING SUMMARY SHEET
BORING WLA B-1

FIGURE 2.5-71 REV. 1



Notes:
1. Elevation of ground surface at boring is 133.6 feet.
2. Boring started on July 30, 2002, and completed on August 2, 2002
3. SPT field blows determined with a 140 lb. hammer, and 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" Mud rotary hole diameter
- 4" Wireline corehole diameter

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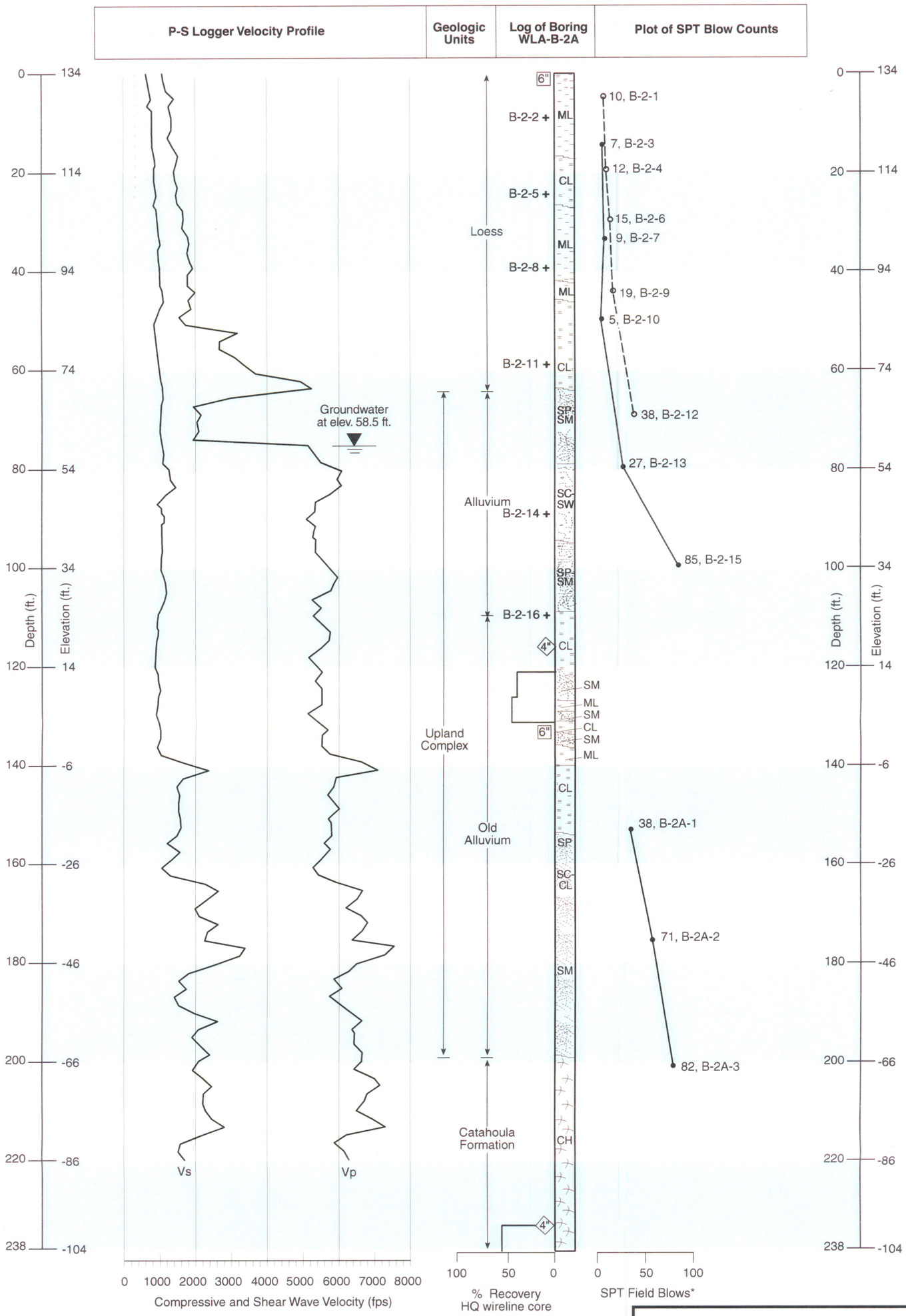
BORING SUMMARY SHEET
BORING WLA B-2

FIGURE 2.5-72 REV. 1



Notes:
1. Downhole geophysics in bald hole preformed 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

Sampler type and number

- • 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

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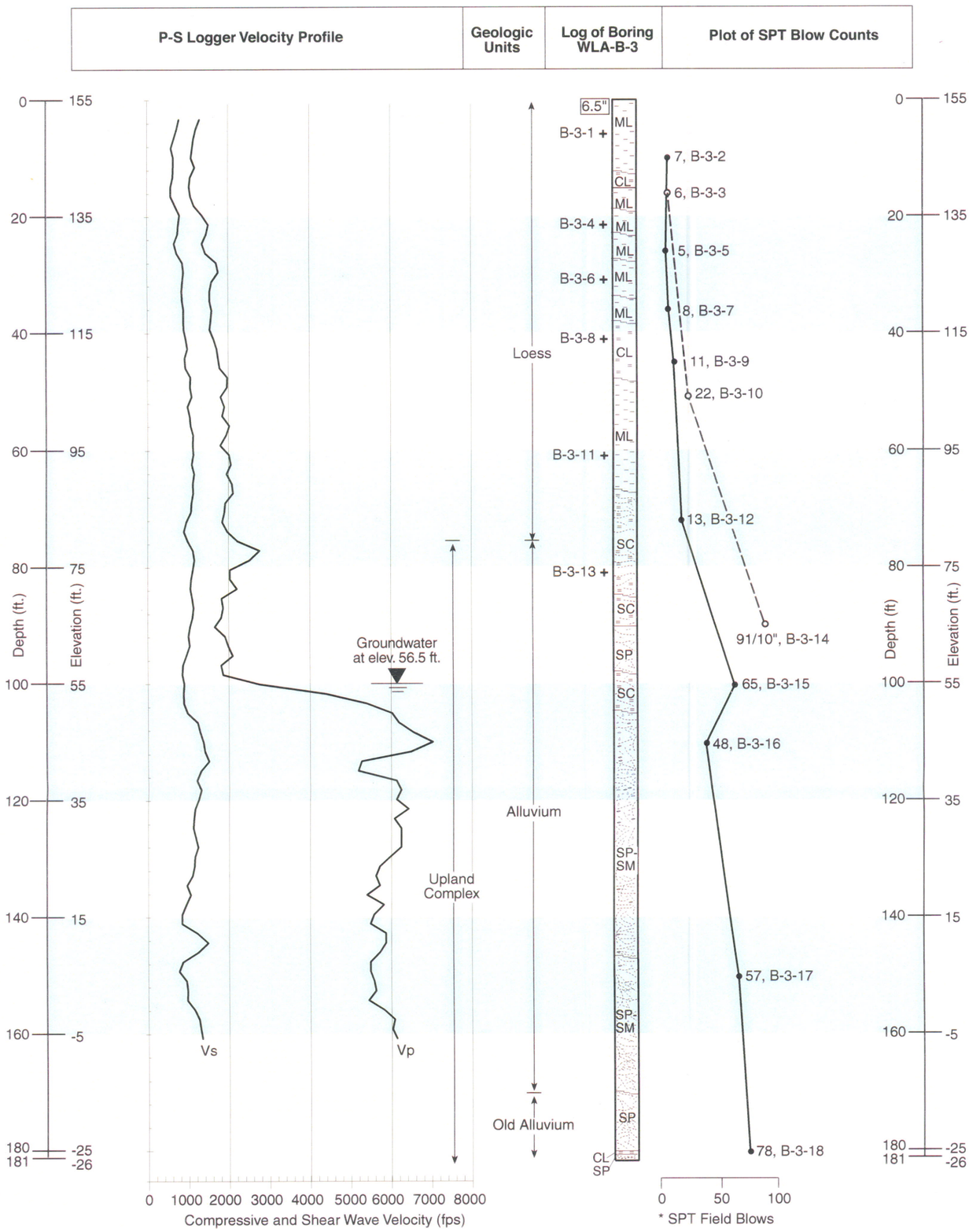
BORING SUMMARY SHEET,
BORING WLA B-2A

FIGURE 2.5-73 REV. 1



Notes:
1. Downhole geophysics in bald hole preformed 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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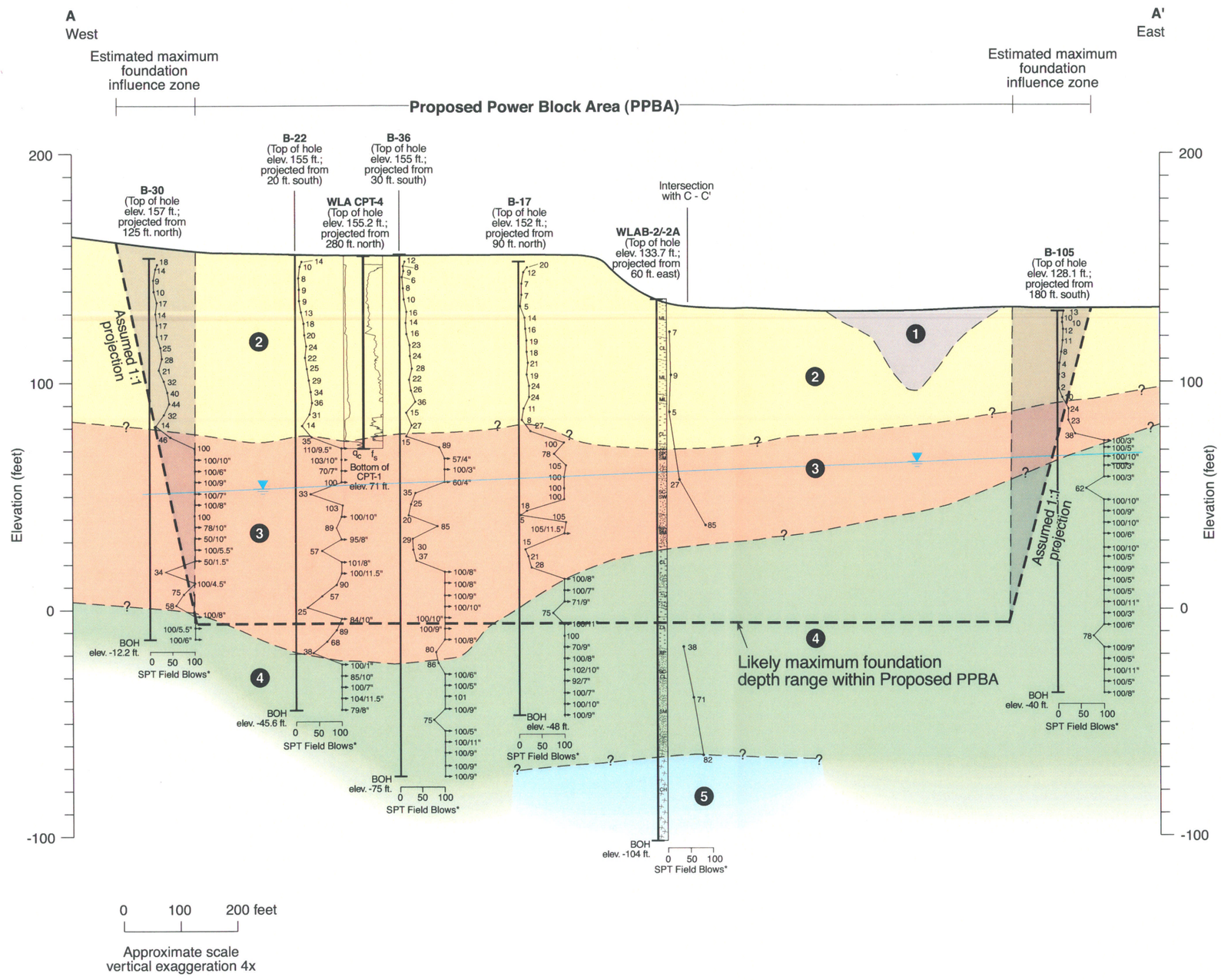
BORING SUMMARY SHEET,
BORING B-3

FIGURE 2.5-74 REV. 1



Explanation

1. Fill (infilled topographic swale)
2. Loess
3. Alluvium } Upland Complex
4. Old alluvium } Upland Complex
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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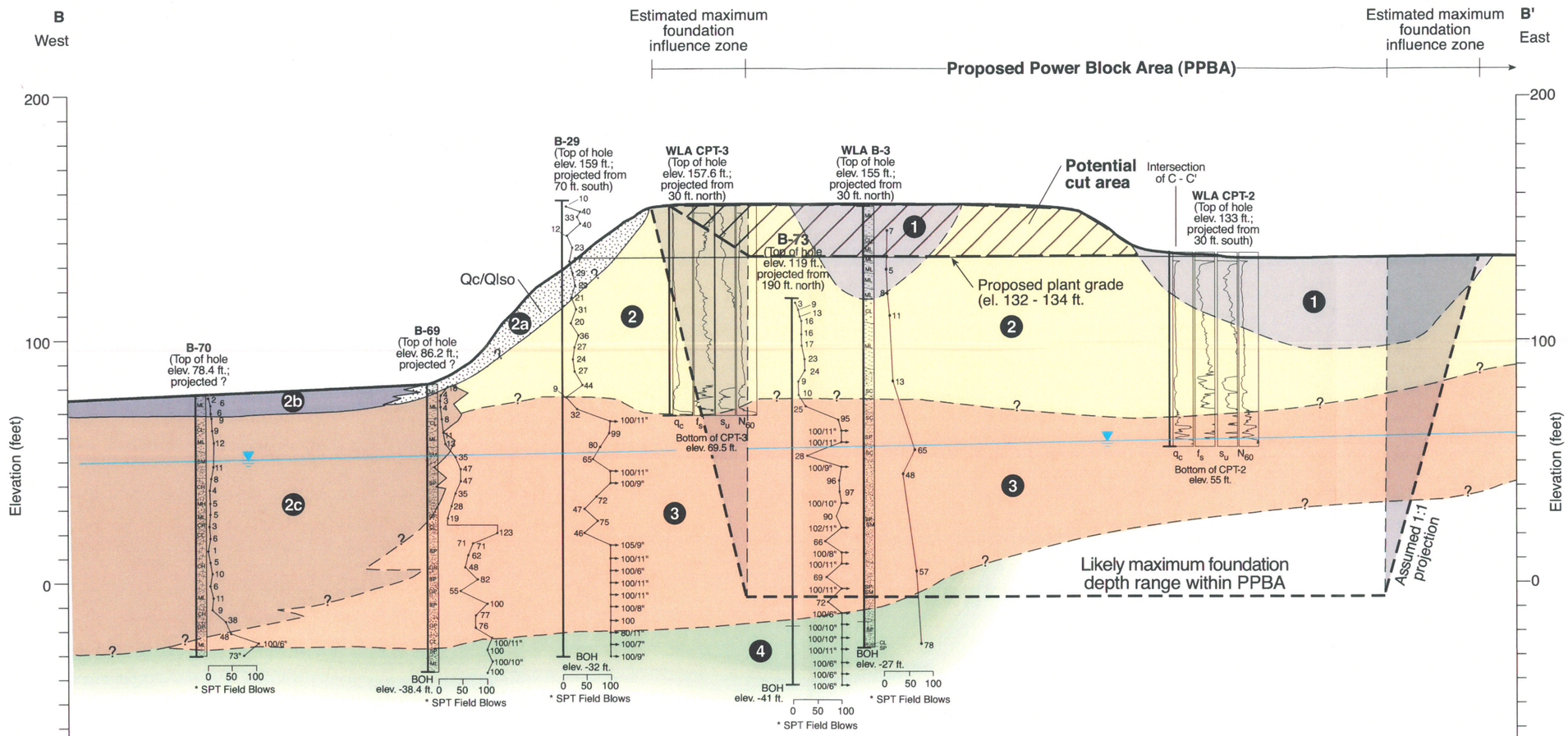
GEOLOGIC SECTION A - A'

FIGURE 2.5-75

REV. 1



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 } Upland Complex
- 4 Old alluvium } Upland Complex
- Groundwater table measured in July/August 2002 by P-S geophysical logging
- Potential cut area

0 100 200 feet

Approximate scale
vertical exaggeration 4x

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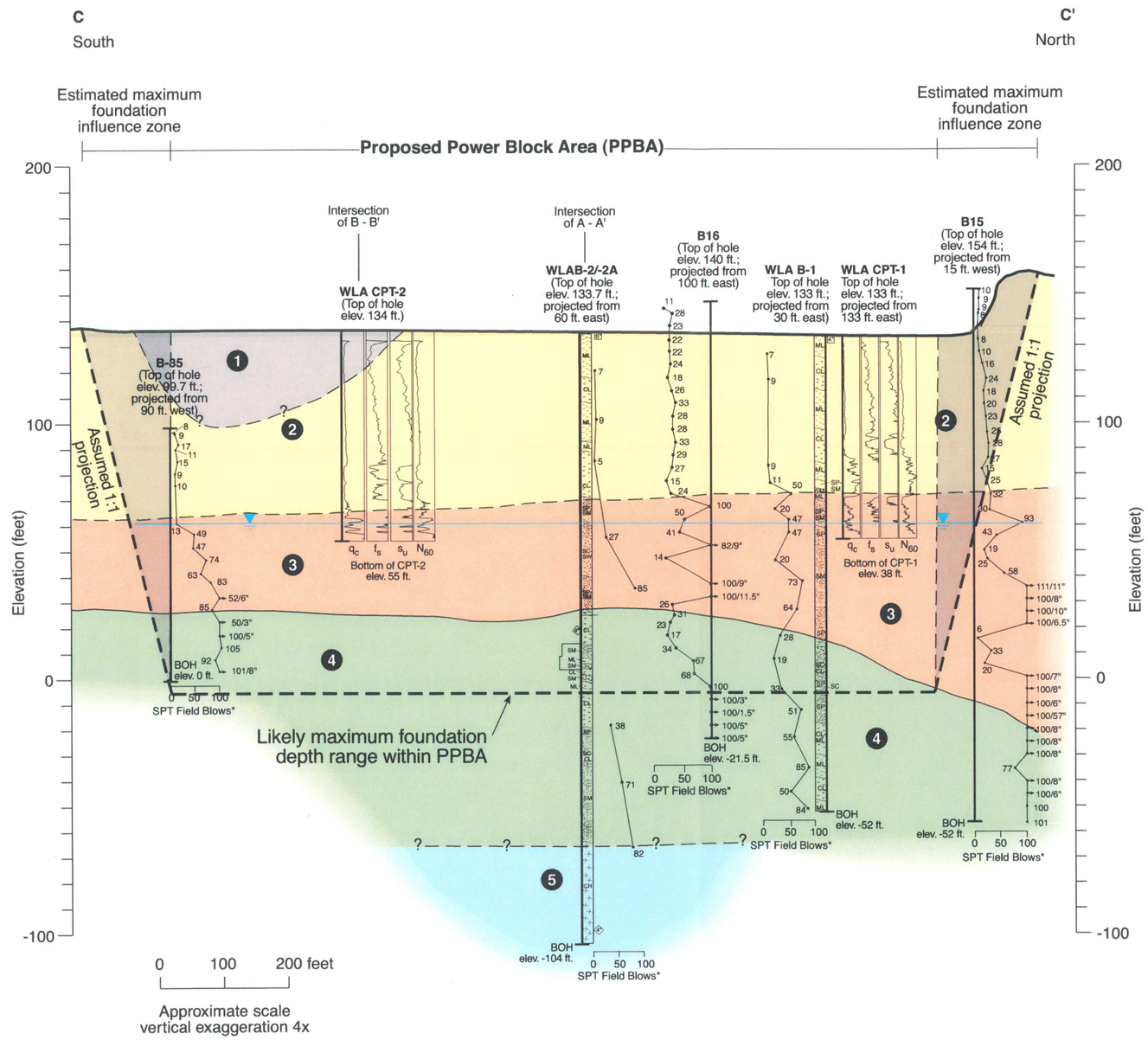
GEOLOGIC SECTION B - B' (EXTENDED)

FIGURE 2.5-76

REV. 1



Explanation

1. Fill (infilled topographic swale)
2. Loess
3. Alluvium — Upland Complex
4. Old alluvium — Upland Complex
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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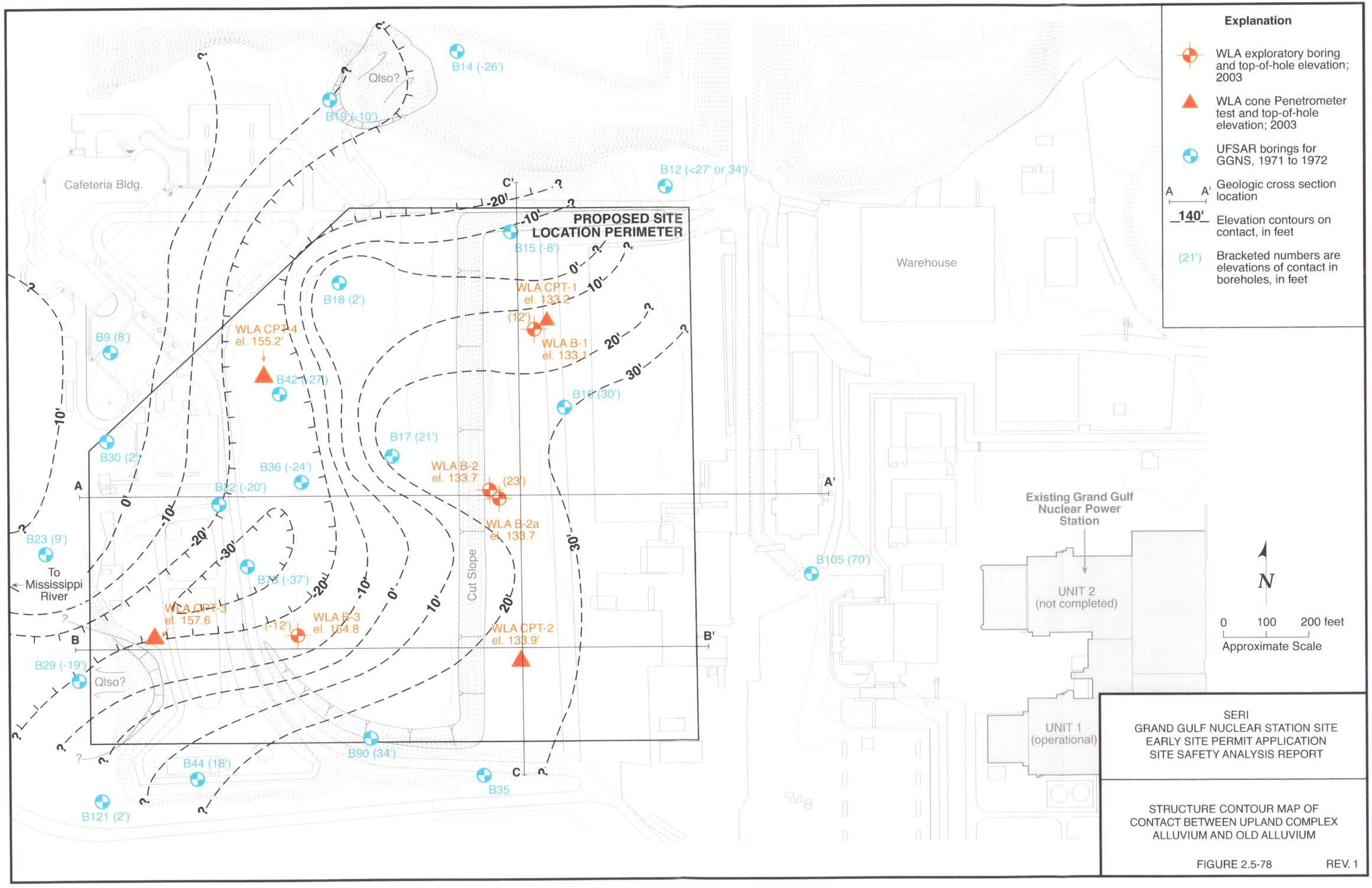
GEOLOGIC SECTION C - C'

FIGURE 2.5-77

REV. 1



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

FIGURE 2.5-78 REV. 1