2.5.5 Stability of Slopes

This section presents information on the stability of permanent slopes at the NAPS site. The information has been developed in accordance with Review Standard RS-002, "Processing Applications for Early Site Permits" (Reference 145), following the guidance presented in RG 1.70, Section 2.5.5 (Reference 3). The geological, geophysical, geotechnical and seismological information presented in this section is used as a basis to evaluate the stability of specific slopes at the site.

The information presented in this section was developed from a review of reports prepared for the existing units and the abandoned Units 3 and 4, geotechnical literature, and a subsurface investigation conducted for preparation of this ESP application. The review included the site-specific reports from the UFSAR (Reference 5), and reports prepared by Dames and Moore regarding the design and construction of the existing units (Reference 7) and the abandoned Units 3 and 4 (Reference 8).

A 55-foot high, 2-horizontal to 1-vertical (2h:1v) slope descends from north of the SWR down to south of the existing excavation made for abandoned Units 3 and 4. This slope was excavated during construction of the existing units, and is almost entirely in cut material. The top of this slope is 200 feet from the top of the SWR embankment, and thus any potential instability of the slope would have no impact on the stability of the SWR embankment.

The only new permanent slope that may be created in association with the new units would be to the west of the SWR to accommodate the buried UHSs for certain new unit designs. The amount (if any) of this cut depends on the design that would be selected. The maximum slope height envisioned is about 55 feet, cut at a 2h:1v slope. The top of the slope would be at least 200 feet from the top of the SWR embankment, the same distance as for the existing slope to the north of the SWR. Thus, any instability of the new slope would not impact the SWR.

Although instability of the existing and possible new 2h:1v slopes would not impact the SWR, sloughing or collapse of these slopes could impact the new units, depending on their final location. The stability of these slopes is addressed in the following sections. The new slopes of the non-safety-related, deepened intake channel, which would be used for the normal cooling water system supply of the new units, would be analyzed during detailed design, if required. Such analysis is not part of the ESP SSAR.

2.5.5.1 Existing Slope Characteristics

The location and direction of the existing 2h:1v slope to the north of the SWR is shown in plan view in Figure 2.5-65; the location is also shown in the photograph in Figure 2.5-66. The photograph in Figure 2.5-67 shows the existing slope clearly, descending from the SWR to close to the excavation for the now abandoned Unit 3 and 4 containment buildings. The structure behind the slope on the SWR embankment is the Unit 1 and 2 valve house, which was originally designed to be the now abandoned Unit 3 and 4 pump house. A cross-section through the existing slope is shown on Figure 2.5-68.

2.5.5.1.1 **Slope Borings**

As shown in Figure 2.5-65, two borings (B-15 and B-18) were performed previously on or close to the area of the slope. These borings were conducted for the Unit 1 and 2 investigation. The profiles of these borings are included in Figure 2.5-68. The boring logs are presented in Section 2.5.5.3. No additional exploration for the slope was made during the ESP exploration program.

2.5.5.1.2 **Slope Subsurface Conditions**

The ESP site soils and bedrock are described in detail in Section 2.5.4.2.2. As can be seen from Figure 2.5-68, the soils in the slope consist almost entirely of Zone IIA saprolites. Saprolites are a further stage of weathering beyond weathered rock. They have been derived by in-place disintegration and decomposition and have not been transported. Saprolites are classified as soils but still contain the relict structure of the parent rock, and they also typically still contain some core stone of the parent rock. The North Anna saprolites in many instances maintain the foliation characteristics of the parent rock. They are mainly classified as silty sands, although there are also sands, clayey sands, sandy silts, clayey silts and clays, depending very much on their degree of weathering. The fabric is strongly anisotropic. The texture shows angular geometrically interlocking grains with a lack of void network, very unlike the well-pronounced voids found in marine or alluvial sands and silts. The Zone IIA saprolites comprise, on average, about 80 percent of the saprolitic materials onsite. About 75 percent of the Zone IIA saprolites are classified as coarse-grained (sands, silty sands) while the remainder are fine-grained (clayey sands, sandy and clayey silts, and clays). The majority of the saprolites obtained from the borings in the slope area are dense silty sands.

The bedrock beneath the Zone IIA saprolite ranges from moderately to severely weathered (Zone III), to fresh to slightly weathered (Zone IV). The bedrock throughout the North Anna site is classified as a gneiss, which is a metamorphic rock that exhibits a banded texture (foliation) in which light and dark bands alternate. It is composed of feldspar, quartz, and one or more other minerals such as mica and hornblende. The majority of the bedrock obtained from the borings in the slope area is a dark green or gray to black biotite hornblende gneiss.

The engineering properties of the site soils and bedrock are described in Section 2.5.4.2.5 and are tabulated in Table 2.5-45. These properties are based on extensive field and laboratory testing described in Section 2.5.4.3 and Section 2.5.4.2, respectively.

The liquefaction characteristics of all of the Zone IIA saprolite are thoroughly examined in Section 2.5.4.8. That section concludes that the results of the liquefaction analysis indicate that some of the Zone IIA saprolitic soils have a potential for liquefaction based on the ESP seismic parameters. The liquefaction analysis did not take into account the beneficial effects of age, structure, fabric, and mineralogy.

2.5.5.1.3 Slope Phreatic Surface

The postulated phreatic surface is shown in Figure 2.5-68 for the existing slope. This surface has been developed from the water table levels derived in Section 2.4.12. The depth of this phreatic surface precludes any potential for liquefaction of the near-surface soils in the slope.

2.5.5.2 Design Criteria and Analyses

2.5.5.2.1 Required Factor of Safety

The following factors of safety are proposed by the Department of the Army (Reference 183):

Condition	Minimum Factor of Safety
End of Construction	1.4
Long-Term Static (non-seismic)	1.5
Long-Term Seismic	1.1

2.5.5.2.2 Stability of Existing Slope

The photograph in Figure 2.5-67 of the existing 2h:1v slope to the north of the SWR was taken about 20 years ago. The condition of the slope is essentially the same today. It was thoroughly inspected during the ESP site investigation. The slope shows no signs of distress.

2.5.5.2.3 Analysis of Existing Slope

The static and dynamic stability of the existing slope to the north of the SWR was analyzed using the computer program SLOPE/W (Reference 184).

a. **Long-Term Static Analysis**

   The SLOPE/W Program used the Bishop method of slices (Reference 185) for analysis of the long-term static condition. The analysis assumed the saprolite was predominantly coarse grained (as shown in borings B-15 and B-18 close to the slope). The effective strength parameters given in Table 2.5-45 were an angle of internal friction $\phi' = 30$ degrees and effective cohesion $c' = 0.25$ ksf for the coarse-grained saprolite.

   The input to the analysis and the results are shown in Figure 2.5-69. The computed factor of safety is about 1.75. This value is above the minimum 1.5 factor of safety required.

b. **Seismic Slope Stability Analysis**

   The pseudo-static approach is used as a first approximation for the seismic analysis of slopes. In this approach, the horizontal and vertical seismic forces are assumed to act on the slope in a static manner, that is, as a constant static force. This is an obviously conservative approach, since the actual seismic event occurs for only a short period of time, and during that time, the forces alternate their direction at a relatively high frequency. Also, the pseudo-static analysis tends to be run using the peak seismic acceleration; the mean acceleration during the design seismic event is significantly less than the peak value. A pseudo-static analysis using peak acceleration values can be a useful tool in a limit analysis where the peak acceleration is relatively low. In such analyses, the computed factor of safety may well exceed the minimum of 1.1, thus requiring no further analysis. However, where the peak seismic acceleration values are high, the pseudo-static analysis produces unreasonably low safety factor values.

The pseudo-static analysis was run using SLOPE/W. For the high frequency earthquake, the peak horizontal acceleration used was 0.65g. This is the average peak acceleration in the top 55 feet of unimproved soil shown in Table 2.5-46 for 150 percent G_{max}. (The maximum horizontal acceleration is 0.99g at the ground surface.) The vertical acceleration used was 0.325g. The computed factor of safety was significantly less than the required 1.1. For the low frequency earthquake, the equivalent peak horizontal acceleration used was 0.26g with a vertical acceleration of 0.13g. The computed factor of safety was slightly less than 1.1.

Seed (Reference 186), in the 19th Rankine Lecture, addressed the over-conservatism intrinsic in the pseudo-static analysis. He looked at the more rational approach proposed by Newmark (Reference 187), where the effective acceleration time-history is integrated to determine velocities and displacements of the slope. He also examined dams in California that had been subjected to seismic forces, including several dams that survived the 1906 San Francisco earthquake. Based on his studies, he concluded that for embankments that consist of materials that do not tend to build up large pore pressures or lose significant percentages of their shear strength during seismic shaking, seismic coefficients of only 0.15g are adequate to ensure acceptable embankment performance for earthquakes up to Magnitude M = 8.25 with peak ground accelerations of 0.75g. For earthquakes in the range of M = 6.5, Seed recommends a horizontal seismic coefficient of only 0.1g with a vertical seismic coefficient of zero.

The liquefaction analysis of the Zone IIA saprolite indicated some of the material has a potential for liquefaction. However, its age, fabric and interlocking angular grain structure, along with the significant portion of low plasticity clay minerals present in the material, have been demonstrated to give the grain structure a low susceptibility to pore pressure build-up or liquefaction (Section 2.5.4.8). This material would not lose a significant proportion of its shear strength during shaking. Thus, for the low frequency earthquake, with a design Magnitude M = 7.2, the pseudo-static analysis should be limited to a horizontal acceleration of only 0.15g.

Although the 0.99g computed peak ground acceleration from the high frequency earthquake at North Anna is greater than the 0.75g referenced by Seed, the highest accelerations are in the top 5 feet of the soil – the average acceleration in the soil is closer to 0.62g below the top 5 feet. In addition, the design high frequency earthquake has a relatively low energy (Magnitude 5.4), which is significant when estimating its potential impact on slope stability. Thus, at North Anna, a pseudo-static design using an inertia force of 0.1g will be adequate for the high frequency earthquake.

The pseudo-static analysis was again run using SLOPE/W. This time the horizontal accelerations used were 0.1g and 0.15g, with zero vertical acceleration. The computed factors of safety were greater than 1.1. The input to the analysis and the results for the 0.1g case are shown in Figure 2.5-70.

Other researchers have also recommended substantially reducing the peak acceleration when applying the pseudo-static analysis. Kramer (Reference 188) recommends using an acceleration of 50 percent of the peak acceleration. Using the average peak acceleration for the high frequency earthquake in the top 55 feet of 0.65g, the horizontal input using Kramer's recommendation would be 0.325g and the vertical input would be 0.1625g. This level of input provides a factor of safety against slope failure just above 0.9. Although this is somewhat less than the required factor of safety of 1.1, it is considered marginal based on the high level of seismic acceleration being applied and the relatively low energy level of the design earthquake. For the low frequency earthquake, where the average peak acceleration in the top 55 feet is about 0.26g, the horizontal input using Kramer's recommendations would be 0.13g and the vertical input would be about 0.065g. This results in a factor of safety of greater than the required 1.1.

Based on the possibility of some liquefaction in the slope area and the marginal results obtained using Kramer's method, measures would be taken to ensure the safety of the slope and of the structures that may be located close to the bottom of the slope. These measures are outlined in Section 2.5.5.6.

2.5.5.3 **Logs of Borings**

As noted in Section 2.5.5.1, two sample borings were drilled on or close to the existing 2h:1v slope to the north of the SWR. The logs of borings B-15 and B-18 are reproduced in Figure 2.5-71 and Figure 2.5-72, respectively.

2.5.5.4 **Compacted Fill**

The existing 2h:1v slope described and analyzed in the previous sections is a cut slope and does not contain fill materials in any significant quantity.

2.5.5.5 **Proposed New Slope**

As noted at the beginning of Section 2.5.5, a new slope may be excavated to the west of the SWR to accommodate UHSs for the new units. The new slope would be approximately the same height and would have the same 2h:1v slope as the existing slope presented in Section 2.5.5.1 through Section 2.5.5.4. It would also be a cut slope like the existing slope, and would comprise similar materials to those in the existing slope. Therefore, the analytical conclusions for the existing slope would apply to the new slope, namely the new slope would be stable under seismic and long-term static conditions.

If the selected design for the new units requires that the new slope be constructed, and it is deemed that any failure of the slope could impact the new units, then investigation and analysis of the slope would be performed as part of detailed engineering and described in the COL application. If the analysis, based on the subsurface investigation results, showed an inadequate factor of safety against slope failure, then the design would be modified to eliminate any risk of slope failure. Such modifications are outlined in Section 2.5.5.6.

2.5.5.6 **Conclusions**

Existing slopes and embankments that are not impacted by the new units (such as the SWR embankments) are not analyzed. New slopes of the non-safety-related, deepened intake channel, which would be used for the normal cooling water system supply of the new units, would be analyzed during detailed design, if required. Such analysis is not part of the ESP SSAR.

The only existing slope whose failure could adversely affect the safety of the new units because of its proximity to the ESP site is a 55-foot high, 2h:1v slope that descends from north of the SWR down to south of the existing excavation made for abandoned Units 3 and 4. The slope is made almost entirely in cut material. Static long-term analyses of the existing slope using the computer program SLOPE/W gave values of factor of safety in excess of the minimum 1.5 required. Pseudo-static analyses using ESP design values of horizontal and vertical seismic acceleration gave safety factor values less than the minimum acceptable value of 1.1 for the high frequency earthquake. However, when the seismic input was modified to conform to the reductions given by Seed (Reference 186), the computed safety factors against slope failure were in excess of 1.1. The Seed reductions are considered reasonable and valid. When the Kramer recommendations were applied, the computed factor of safety against seismic slope failure was considered satisfactory for the low frequency earthquake and marginal for the high frequency earthquake. Based on the possibility of some liquefaction in the slope area and the marginal results obtained using Kramer's method, measures would be taken to ensure the safety of the slope and of the structures that may be located close to the bottom of the slope. These measures could include reducing the slope steepness, removing and replacing materials that could lose significant strength during the design earthquake, ground improvement measures such as soil nailing, moving structures further from the toe of the slope, and/or providing walls/barriers to protect those structures.

A new slope may be excavated to the west of the SWR to accommodate UHSs for the new units. The new slope would be approximately the same height, would have the same 2h:1v slope, and would have the same soil and rock characteristics as the existing slope that was analyzed. If analysis during the design stage of this slope indicates unacceptable factors of safety against slope failure, modifications such as those proposed for the existing slope in the previous paragraph would be employed.

2.5.6 **Embankments and Dams**

Because Lake Anna would only be used for normal plant cooling of the new units, the North Anna Dam, which is designed and constructed to meet requirements for a seismic Category I structure in support of the existing units, was not re-analyzed as part of this application. Analysis of the new non-safety-related deepened intake channel slopes for the new units would be performed during detailed design.

Construction of the new units would not adversely affect the slopes of the SWR for the existing units. There is an existing 55-foot high embankment to the north of the SWR and to the south of the new units. A similar embankment may be constructed to the west of the SWR to accommodate the buried UHS of certain reactor designs that might be constructed on the ESP site. Instability of these slopes could affect the new units. This is described and presented in Section 2.5.5.

In summary, there are no embankments and dams to be addressed in this section.

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Table 2.5-1 Definitions of Classes Used in the Compilation of Quaternary Faults, Liquefaction Features, and Deformation in the Central and Eastern United States (After Crone and Wheeler, 2000)

Class Category	Definition
Class A	Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction to other deformational features.
Class B	Geologic evidence demonstrates the existence of a fault or suggests Quaternary deformation, but either: 1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or 2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.
Class C	Geologic evidence is insufficient to demonstrate: 1) the existence of tectonic fault, or 2) Quaternary slip or deformation associated with the feature.
Class D	Geologic evidence demonstrates that the feature is not a tectonic fault or feature; this category includes features such as demonstrated joints or joint zones, landslides, erosional or fluvial scarps, or landforms resembling fault scarps, but of demonstrable non-tectonic origin.

Table 2.5-2 Quaternary Faults, Liquefaction Features, and Possible Tectonic Features Within the Site Region (200-Mile Radius) (Modified from Crone)

Feature	State	County	Physiographic Province	Distance from Site (mi.)	Class	Post-EPRI Info. (1986)	Fault Length (mi.)
Central VA Seismic zone	VA	14 counties	Piedmont	0	A	No	NA[a]
Mountain Run/Everona fault zone	VA	Orange, Culpeper, Fauquier	Piedmont	19	C	No	60–90
Lebanon Church fault	VA	Albemarle	Blue Ridge	45	C	No	NR[b]
Upper Marlboro faults	MD	Prince Georges	Coastal Plain	75	C	No	NA[a]
Old Hickory faults	VA	Dinwiddie, Sussex	Coastal Plain	78	C	Yes	0.6–0.09
Stanleytown-Villa Heights fault	VA	Henry	Piedmont	144	C	No	~0.1
Lancaster fault zone	PA	Lancaster	Piedmont	157	C	No	NA[a]
Lindside fault zone	VA, WV	Giles (VA)	Appalachian Plateaus	162	C	Yes	>30
Pembroke faults	VA	Giles	Valley and Ridge	163	B	Yes	NA[a]
Hares Crossroads fault	NC	Johnston	Coastal Plain	165	C	No	NR[b]
Cacoosing Valley earthquake	PA	Berks	Valley and Ridge	186	C	Yes	NA[a]

a. NA: Not Applicable

b. NR: Not Reported

Table 2.5-3 Site Area Stratigraphic Column (5-Mile Radius)

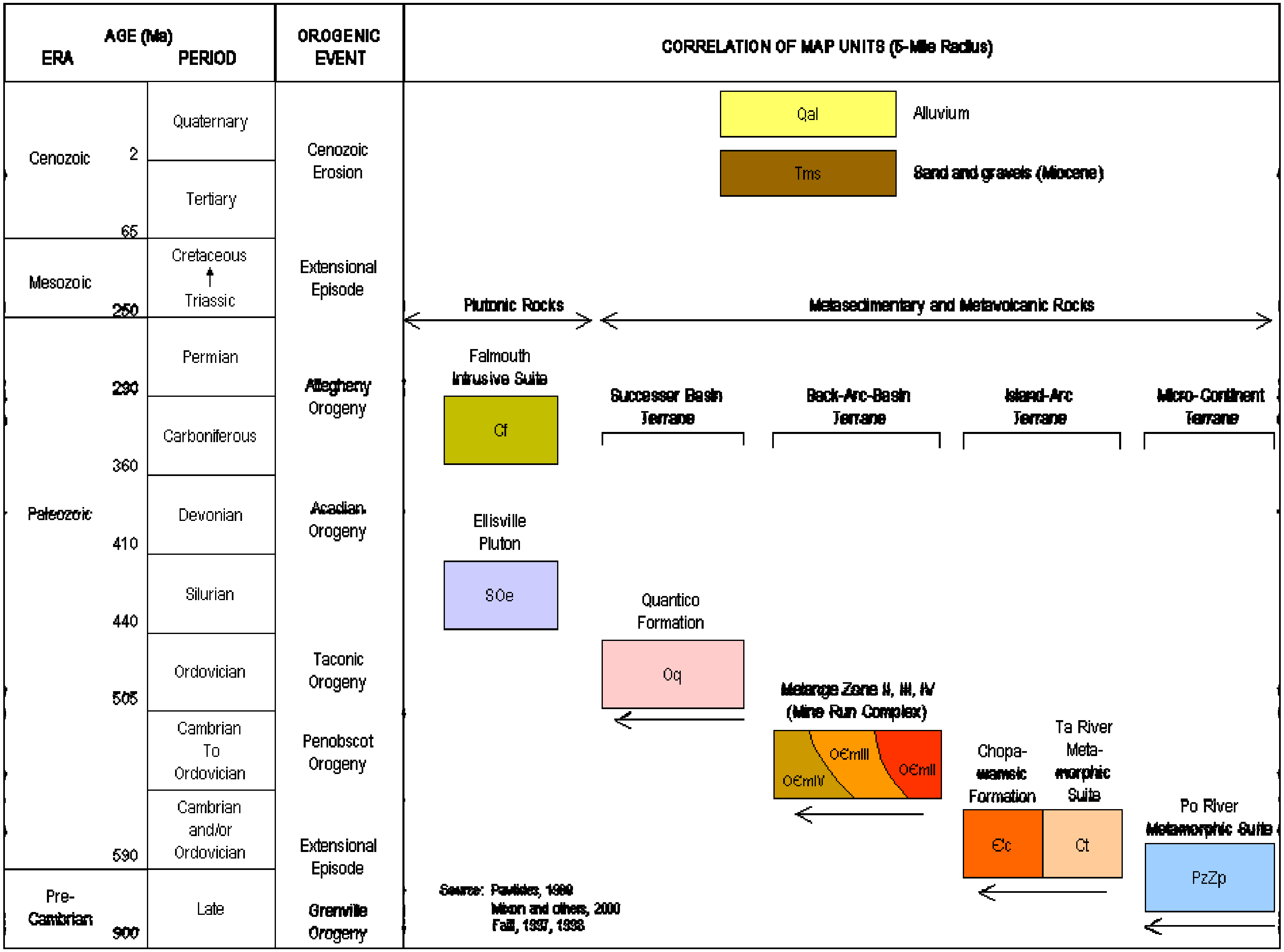


Table 2.5-4 Earthquakes 1985-2001, m≥3.0, within 35°N–41°N and 74°W–82°W

Year	Month	Day	Latitude North	Longitude West	Depth km	m_b	m(coda)	m(int)	ML	m(unk)	Source
1985	6	10	37.248	80.485	11.1	3.2	2.8	3.3			VT
1986	3	26	37.245	80.494	11.9		2.9	3.3			VT
1986	12	3	37.58	77.458	1.6		1.5	3.3			VT
1986	12	10	37.585	77.468	1.2	2.5	2.2	3.5			VT
1986	12	24	37.583	77.458	1		1.6	3.3			VT
1987	1	13	37.584	77.465	2.5		1.9	3.3			VT
1988	5	28	39.753	81.613	0					3.4	ANSS
1988	8	27	37.718	77.775	14.3		2.7	3.3			VT
1990	1	13	39.366	76.851	4.1	2.5	2.6	3.5			VT
1991	3	15	37.746	77.909	15.5	3.8	3.3	3.5			VT
1991	4	22	37.942	80.205	14.8	3.5	3.5	3.3			VT
1991	6	28	38.231	81.335	7	3.0					VT
1991	8	15	40.786	77.657	1					3.0	ANSS
1992	1	9	40.363	74.341	7.9					3.1	ANSS
1993	3	10	39.233	76.882	5		2.5	3.3			VT
1993	3	15	39.197	76.87	0.9	2.7	2.1	3.5			VT
1993	7	12	36.035	79.823	5	2.7		3.3			VT
1993	10	28	39.25	76.77			2.1	3.3			VT
1993	10	28	39.25	76.77			1.8	3.3			VT
1994	1	16	40.327	76.007	5	4.2					ANSS
1994	1	16	40.33	76.037	5	4.6					ANSS
1994	8	6	35.101	76.786	0	3.6	3.8	3.5			VT
1995	6	26	36.752	81.481	1.8	3.4	3.3				VT
1995	7	7	36.493	81.833	10	3.0	3.1				VT
1997	11	14	40.146	76.252	5				3.0		ANSS
1997	11	14	40.741	76.549	0		3.0				VT
1998	6	5	35.554	80.785	9.4	3.2	3.4				VT
1998	10	21	37.422	78.439	12.6	3.8	3.4				VT
2001	9	22	38.026	78.396	0.4	3.2	2.5				VT
2001	12	4	37.726	80.752	8.5	3.1					VT

Table 2.5-5 Summary of Bechtel Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
Sources within 200 mi (320 km)										
E	Central Virginia	0	0	0.35	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	Yes	No	No	No
BZ5	S. Appalachians	0	0	1.00	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 3 [0.33]	Yes	No	No	No
24	Bristol Trends	61	38	0.25	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	Yes	No	No	No
BZ4	Atlantic Coastal Region	144	90	1.00	6.6 [0.10] 6.8 [0.40] 7.1 [0.40] 7.4 [0.10]	1 [0.33] 2 [0.34] 3 [0.33]	Yes	No	No	No
----------										
17	Stafford fault zone	0	0	0.10	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	No	No	No	No
13	Eastern Mesozoic Basins	5	3	0.10	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	No	No	No	No
25	NY-Alabama Lineament	189	118	0.30	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	No	No	No	No
23	Lebanon Trend	211	131	0.05	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	No	No	No	No
19	Giles County	221	137	0.35	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	No	No	No	No

Table 2.5-5 Summary of Bechtel Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
BZ6	SE. Craton Region	229	142	1.00	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 3 [0.33]	No	No	No	No
F	SE. Appalachians	274	170	0.35	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	1 [0.33] 2 [0.34] 4 [0.33]	No	No	No	No
Selected Sources Beyond 200 mi (320 km)										
H	Charleston Area	545	339	0.50	6.8 [0.20] 7.1 [0.40] 7.4 [0.40]	1 [0.33] 2 [0.34] 4 [0.33]	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs
N3	Charleston Faults	579	359	0.53	6.8 [0.20] 7.1 [0.40] 7.4 [0.40]	1 [0.33] 2 [0.34] 4 [0.33]	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs

a. Closest Distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Smoothing options are defined as follows (from Reference 121):
1 = constant a, constant b (no prior b);
2 = low smoothing on a, high smoothing on b (no prior b);
3 = low smoothing on a, low smoothing on b (no prior b);
4 = low smoothing on a, low smoothing on b (weak prior of 1.05).
Weights on magnitude intervals are [1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0].

e. Did the source contribute to 99% of EPRI hazard calculated at NAPS?; from Table 2.5-18.

f. No, unless new geometry proposed in literature.

g. No, unless EPRI M_{max} exceeded in literature. For Charleston, M_{max} from Reference 127 and weights even though new magnitude estimates do not generally exceed majority of EPRI M_{max} values.

h. RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed per Section 2.5.2.6.5.

Table 2.5-6 Summary of Dames & Moore Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
Sources within 200 mi (320 km)										
41	S. Cratonic Margin (Default Zone)	0	0	0.12	6.1 [0.80] 7.2 [0.20]	1 [0.75] 2 [0.25]	Yes	No	No	No
53	S. Appalachian Mobile Belt (Default Zone)	6	4	0.26	5.6 [0.80] 7.2 [0.20]	1 [0.75] 2 [0.25]	Yes	No	No	No
40	Central VA Seismic Zone	24	15	1.00	6.6 [0.80] 7.2 [0.20]	1 [0.75] 2 [0.25]	Yes	No	No	No
42	Newark-Gettysburg Basin	32	20	0.40	6.3 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	Yes	No	No	No
47	Connecticut Basin	41	25	0.28	6.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	Yes	No	No	No
4	Appalachian Fold Belts	74	46	0.35	6.0 [0.80] 7.2 [0.20]	1 [0.75] 2 [0.25]	Yes	No	No	No
4B	Kink in Fold Belt (Giles Co. Area)	145	90	0.65	6.2 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	Yes	No	No	No
44	Stafford Fault Zone	34	21	1.00	5.0 [0.80] 7.2 [0.20]	1 [0.69] 2 [0.23] 3 [0.06] 4 [0.02]	No	No	No	No
C01	Combination zone 4-4A-4B-4C-4D	74	46	NA	6.0 [0.80] 7.2 [0.20]	1 [0.75] 2 [0.25]	No	No	No	No
45	Hopewell Fault Zone	87	54	1.00	5.0 [0.80] 7.2 [0.20]	1 [0.69] 2 [0.23] 3 [0.06] 4 [0.02]	No	No	No	No
46	Dan River Basin	118	74	0.28	6.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No
4C	Kink in Fold Belt	173	108	0.65	5.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No
48	Buried Triassic Basins	175	108	0.28	6.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No

Table 2.5-6 Summary of Dames & Moore Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
8	E. Marginal Basin	188	117	0.08	5.6 [0.80] 7.2 [0.20]	1 [0.75] 2 [0.25]	No	No	No	No
C02	Combination zone 8-9	188	117	NA	5.6 [0.80] 7.2 [0.20]	1 [0.75] 2[0.25]	No	No	No	No
49	Jonesboro Basin	204	127	0.28	6.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No
6	Rome Trough	218	135	0.24	5.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No
7	Dunkard Basin	281	175	0.38	5,7 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No
50	Buried Triassic Basins	290	180	0.28	6.0 [0.75] 7.2 [0.25]	3 [0.75] 4 [0.25]	No	No	No	No
Selected Sources Beyond 200 mi (320 km)										
54	Charleston Seismic Zone	533	331	1.00	6.6 [0.75] 7.2 [0.25]	1 [0.22] 2 [0.08] 3 [0.52] 4 [0.18]	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs

a. Closest Distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Smoothing options are defined as follows (from Reference 121):
1 = No smoothing on a, no smoothing on b (strong prior of 1.04);
2 = No smoothing on a, no smoothing on b (weak prior of 1.04);
3 = Constant a, constant b (strong prior of 1.04);
4 = Constant a, constant b (weak prior of 1.04).
Weights on magnitude intervals are [0.1, 0.2, 0.4, 1.0, 1.0, 1.0, 1.0]

e. Did the source contribute to 99% of EPRI hazard calculated at NAPS?; from Table 2.5-18.

f. No, unless new geometry proposed in literature.

g. No, unless EPRI M_{max} exceeded in literature. For Charleston, M_{max} from Reference 127 and weights even though new magnitude estimates do not generally exceed majority of EPRI M_{max} values.

h. RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed per Section 2.5.2.6.5.

Table 2.5-7 Summary of Law Engineering Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
					Sources within 200 mi (320 km)					
17	Eastern Basement	0	0	0.62	5.7 [0.20] 6.8 [0.80]	1b [1.00]	Yes	No	No	No
217	Eastern Basement Background	0	0	1.00	4.9 [0.50] 5.7 [0.50]	1b [1.00]	Yes	No	No	No
GC011	22 - 35	7	4	NA	6.8 [1.00]	2a [1.00]	Yes	No	No	No
107	Eastern Piedmont	7	4	1.00	4.9 [0.30] 5.5 [0.40] 5.7 [0.30]	1a [1.00]	Yes	No	No	No
22	Reactivated E. Seaboard Normal	7	4	0.27	6.8 [1.00]	2a [1.00]	Yes	No	No	No
M22	Mafic Pluton	23	14	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
GC09	Mesozoic Basins (8 - Bridged)	28	18	NA	5.0 [0.20] 5.8 [0.50] 7.4 [0.30]	1c [1.00]	Yes	No	No	No
C10	Combination Zone 8-35	28	18	NA	6.8 [1.00]	2a [1.00]	Yes	No	No	No
M21	Mafic Pluton	47	29	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
M23	Mafic Pluton	73	45	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
M20	Mafic Pluton	79	49	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
M24	Mafic Pluton	81	50	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
M27	Mafic Pluton	152	94	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
M19	Mafic Pluton	159	98	0.43	6.8 [1.00]	5 [1.00]	Yes	No	No	No
GC13	22 - 24 - 35	7	4	NA	6.8 [1.00]	2a [1.00]	No	No	No	No
GC12	22 - 24	7	4	NA	6.8 [1.00]	2a [1.00]	No	No	No	No
105	Northern Coastal Plain	60	37	1.00	4.6 [0.90] 4.9 [0.10]	1a [1.00]	No	No	No	No
M25	Mafic Pluton	84	52	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
M26	Mafic Pluton	112	70	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No

Table 2.5-7 Summary of Law Engineering Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
8	Mesozoic Basins	194	120	0.27	6.8 [1.00]	a and b values calculated for C09	No	No	No	No
M28	Mafic Pluton	200	124	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
M18	Mafic Pluton	211	131	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
M29	Mafic Pluton	220	136	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
112	Ohio-Pennsylvania Block	223	138	1.00	4.6 [0.20] 5.1 [0.50] 5.5 [0.30]	1a [1.00]	No	No	No	No
M30	Mafic Pluton	240	149	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
M17	Mafic Pluton	272	169	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
M16	Mafic Pluton	281	175	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
101	Western New England	313	194	1.00	4.5 [0.15] 5.5 [0.85]	1c [1.00]	No	No	No	No
M31	Mafic Pluton	321	199	0.43	6.8 [1.00]	5 [1.00]	No	No	No	No
Selected Sources Beyond 200 mi (320 km)										
35	Charleston Seismic Zone	560	348	0.45	6.8 [1.00]	2a [1.00]	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs

a. Closest Distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Smoothing options are defined as follows (from Reference 121):
1a = High smoothing on a, constant b (strong prior of 1.05);
1b = High smoothing on b, constant b (strong prior of 1.00);
1c = High smoothing on a, constant b (strong prior of 0.95);
1d = High smoothing on a, constant b (strong prior of 0.90);
1e = High smoothing on a, constant b (strong prior of 0.70);
2a = Constant a, constant b (strong prior of 1.05);
2c = Constant a, constant b (strong prior of 0.95);
2d = Constant a, constant b (strong prior of 0.90).
Weights on magnitude intervals are all 1.0 for above options.
3a = High smoothing on a, constant b (strong prior of 1.05).
Weights on magnitude intervals are [0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0] for option 3a.

e. Did the source contribute to 99% of EPRI hazard calculated at NAPS?; from Table 2.5-18.

f. No, unless new geometry proposed in literature.

g. No, unless EPRI M_{max} exceeded in literature. For Charleston, M_{max} from Reference 127 and weights even though new magnitude estimates do not generally exceed majority of EPRI M_{max} values.

h. RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed per Section 2.5.2.6.5.

Table 2.5-8 Summary of Rondout Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
Sources within 200 mi (320 km)										
29	Central VA	0	0	1.00	6.6 [0.30] 6.8 [0.60] 7.0 [0.10]	1 [1.00] (a=-0.900, b=0.930)	Yes	No	No	No
30	Shenandoah	0	0	0.96	5.2 [0.30] 6.3 [0.55] 6.5 [0.15]	1 [1.00] (a=-1.710, b=1.010)	Yes	No	No	No
28	Giles County	188.4	117	1.00	6.6 [0.30] 6.8 [0.60] 7.0 [0.10]	1 [1.00] (a=-1.130, b=0.900)	Yes	No	No	No
49	Appalachian	66.9	42	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]	2 [1.00]	No	No	No	No
C01	Background 49	67	42	NA	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]	3 [1.00]	No	No	No	No
C09	49+32	67	42	NA	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]	3 [1.00]	No	No	No	No
50	Grenville	106.9	66	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]	2 [1.00]	No	No	No	No
C07	50 (02) + 12	107	66	NA	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]	3 [1.00]	No	No	No	No
C02	Background 50	107	66	NA	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]	3 [1.00]	No	No	No	No
32	Norfolk Fracture Zone	114.1	71	0.67	5.8 [0.15] 6.5 [0.60] 6.8 [0.25]	1 [1.00] (a=-2.110, b=1.040)	No	No	No	No
31	Quakers	210.3	131	1.00	5.8 [0.15] 6.5 [0.60] 6.8 [0.25]	1 [1.00] (a=-1.200, b=0.960)	No	No	No	No
Selected Sources Beyond 200 mi (320 km)										
24	Charleston	526	327	1.00	6.6 [0.20] 6.8 [0.60] 7.0 [0.20]	1 [1.00] (a=-0.710, b=1.020)	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs

a. Closest Distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Smoothing options are defined as follows (from Reference 121):
1, 6, 7, 8 = a, b values as listed above, with weights shown;
3 = Low smoothing on a, constant b (strong prior of 1.0);
5 = a, b values as listed above, with weights shown.

e. Did the source contribute to 99% of EPRI hazard calculated at NAPS?; from Table 2.5-18.

f. No, unless new geometry proposed in literature.

g. No, unless EPRI $M_{\mathbf{max}}$ exceeded in literature. For Charleston, $M_{\mathbf{max}}$ from Reference 127 and weights even though new magnitude estimates do not generally exceed majority of EPRI $M_{\mathbf{max}}$ values.

h. RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed per Section 2.5.2.6.5.

Table 2.5-9 Summary of Weston Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
					Sources within 200 mi (320 km)					
22	Central VA Seismic Zone	0	0	0.82	5.4 [0.19] 6.0 [0.65] 6.6 [0.16]	1b [1.00]	Yes	No	No	No
C21	104-25	0	0	NA	5.4 [0.24] 6.0 [0.61] 6.6 [0.15]	1a [0.30] 2a [0.70]	Yes	No	No	No
C22	104-26	0	0	NA	5.4 [0.24] 6.0 [0.61] 6.6 [0.15]	1a [0.30] 1b [0.70]	Yes	No	No	No
C34	104-28BE-26	0	0	NA	5.4 [0.24] 6.0 [0.61] 6.6 [0.15]	1a [0.20] 1b [0.80]	Yes	No	No	No
C35	104-28BE-25	0	0	NA	5.4 [0.24] 6.0 [0.61] 6.6 [0.15]	1a [0.20] 1b [0.80]	Yes	No	No	No
C23	104-22-26	17	10	NA	5.4 [0.80] 6.0 [0.14] 6.6 [0.06]	1a [0.50] 2a [0.50]	Yes	No	No	No
C19	103-23-24	43	27	NA	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]	1a [1.00]	Yes	No	No	No
----	----	----	----	----	----	----	----	----	----	----
104	Southern Coastal Plain	0	0	1.00	5.4 [0.24] 6.0 [0.61] 6.6 [0.15]	1a [0.20] 2a [0.80]	No	No	No	No
C25	104-28BCDE	0	0	NA	5.4 [0.24] 6.6 [0.61] 6.6 [0.15]	1a [0.30] 2a [0.70]	No	No	No	No
C20	104-22	17	10	NA	6.0 [0.85] 6.6 [0.15]	1a [0.30] 2a [0.70]	No	No	No	No
C24	104-22-25	17	10	NA	5.4 [0.80] 6.0 [0.14] 6.6 [0.06]	1a [0.50] 2a [0.50]	No	No	No	No
C26	104-28BCDE-22	17	11	NA	5.4 [0.24] 6.0 [0.61] 6.6 [0.15]	1a [0.30] 2a [0.70]	No	No	No	No
C27	104-28BCDE-22-25	17	11	NA	5.4 [0.30] 6.0 [0.70]	1a [0.70] 2a [0.30]	No	No	No	No
C28	104-28BCDE-22-26	17	11	NA	5.4 [0.30] 6.0 [0.70]	1a [0.70] 2a [0.30]	No	No	No	No

Table 2.5-9 Summary of Weston Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
28B	Zone of Mesozoic Basin	24	15	0.26	5.4 [0.65] 6.0 [0.25] 6.6 [0.10]	1b [1.00]	No	No	No	No
C01	28A thru E	24	15	NA	5.4 [0.65] 6.0 [0.25] 6.6 [0.10]	1b [1.00]	No	No	No	No
28E	Zone of Mesozoic Basin	41	25	0.26	5.4 [0.65] 6.0 [0.25] 6.6 [0.10]	1b [1.00]	No	No	No	No
103	Southern Appalachians	43	27	1.00	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]	1a [0.20] 2a [0.80]	No	No	No	No
C17	103-23	43	27	NA	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]	1a [0.70] 2a [0.30]	No	No	No	No
C18	103-24	43	27	NA	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]	1a [0.70] 1b [0.30]	No	No	No	No
28D	Zone of Mesozoic Basin	116	72	0.26	5.4 [0.65] 6.0 [0.25] 6.6 [0.10]	1b [1.00]	No	No	No	No
28C	Zone of Mesozoic Basin	142	88	0.26	5.4 [0.65] 6.0 [0.25] 6.6 [0.10]	1b [1.00]	No	No	No	No
23	Giles County Seismic Zone	213	132	0.90	6.0 [0.81] 6.6 [0.19]	1b [1.00]	No	No	No	No
102	Appalachian Plateau	234	145	1.00	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]	1a [0.20] 2a [0.80]	No	No	No	No
101	S. Ontario-Ohio-Indiana	236	147	1.00	5.4 [0.19] 6.0 [0.68] 6.6 [0.13]	1a [0.20] 2a [0.80]	No	No	No	No
C12	101-7	236	147	NA	5.4 [0.19] 6.0 [0.68] 6.6 [0.13]	1a [0.70] 2a [0.30]	No	No	No	No
C13	101-8	236	147	NA	5.4 [0.19] 6.0 [0.68] 6.6 [0.13]	1a [0.70] 2a [0.30]	No	No	No	No
C14	101-29	236	147	NA	5.4 [0.19] 6.0 [0.68] 6.6 [0.13]	1a [0.70] 2a [0.30]	No	No	No	No

Table 2.5-9 Summary of Weston Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
C15	101-7-8	236	147	NA	5.4 [0.19] 6.0 [0.68] 6.6 [0.13]	1a [0.70] 2a [0.30]	No	No	No	No
C16	101-7-8-29	236	147	NA	5.4 [0.19] 6.0 [0.68] 6.6 [0.13]	1a [1.00]	No	No	No	No
24	New York-Alabama-Clingman	255	159	0.90	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]	1b [1.00]	No	No	No	No
21	New York Nexus	296	184	1.00	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]	1b [`.00]	No	No	No	No
28A	Mesozoic Basin	296	184	0.26	5.4 [0.65] 6.0 [0.25] 6.6 [0.10]	1b [1.00]	No	No	No	No
C07	21-19	296	184	NA	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]	1b [0.70] 2b [0.30]	No	No	No	No
C08	21-19-10A	296	184	NA	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]	1b [0.70] 2b [0.30]	No	No	No	No
C09	21-19-10A-28A	320	199	NA	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]	1b [1.00]	No	No	No	No
C10	21-19-28A	320	199	NA	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]	1b [1.00]	No	No	No	No
					Selected Sources Beyond 200 mi (320 km)					
25	Charleston Seismic Zone	532	330	0.99	6.6 [0.90] 7.2 [0.10]	1b [1.00]	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs

a. Closest Distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Smoothing options are defined as follows (from Reference 121):
   1a = Constant a, constant b (medium prior of 1.0);
   1b = Constant a, constant b (medium prior of 0.9);
   1c = Constant a, constant b (medium prior of 0.7);
   2a = Medium smoothing on a, medium smoothing on b (medium prior of 1.0);
   2b = Medium smoothing on a, medium smoothing on b (medium prior of 0.9);
   2c = Medium smoothing on a, medium smoothing on b (medium prior of 0.7).

e. Did the source contribute to 99% of EPRI hazard calculated at NAPS?; from Table 2.5-18.

f. No, unless new geometry proposed in literature.

g. No, unless EPRI M_{max} exceeded in literature. For Charleston, M_{max} from Reference 127 and weights even though new magnitude estimates do not generally exceed majority of EPRI M_{max} values.

h. RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed per Section 2.5.2.6.2.

Table 2.5-10 Summary of Woodward-Clyde Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
Sources within 200 mi (320 km)										
B22	North Anna Background	0	0	1.00	5.8 [0.33] 6.2 [0.34] 6.6 [0.33]	1 [0.25] 6 [0.25] 7 [0.25] 8 [0.25]	Yes	No	No	No
26	Central VA Gravity Saddle	4	3	0.434	5.4 [0.33] 6.5 [0.34] 7.0 [0.33]	2 [0.25] 3 [0.25] 4 [0.25] 5 [0.25]	Yes	No	No	No
27	State Farm Complex	5	3	0.474	5.6 [0.33] 6.3 [0.34] 6.9 [0.33]	2 [0.25] 3 [0.25] 4 [0.25] 5 [0.25]	Yes	No	No	No
28	Richmond Basin	41	26	0.092	5.3 [0.33] 6.0 [0.34] 7.2 [0.33]	3 [0.33] 4 [0.34] 5 [0.33]	No	No	No	No
61	Tyrone-Mt. Union Lineament	76	47	0.048	5.4 [0.33] 6.5 [0.34] 7.1 [0.33]	3 [0.33] 4 [0.34] 5 [0.33]	No	No	No	No
63	Pittsburg-Washington Lineament	186	116	0.050	5.4 [0.33] 6.3 [0.34] 7.1 [0.33]	3 [0.33] 4 [0.34] 5 [0.33]	No	No	No	No
21	New Jersey Isostatic Gravity Saddle	192	120	0.135	5.3 [0.33] 6.5 [0.34] 6.9 [0.33]	2 [0.10] 3 [0.10] 4 [0.10] 5 [0.10] 9 [0.60] (a=-1.406, b=1.020)	No	No	No	No
21A	New Jersey Isostatic Gravity Saddle No. 2 (Combo C2)	192	120	0.045	5.5 [0.33] 6.3 [0.34] 7.1 [0.33]	2 [0.10] 3 [0.10] 4 [0.10] 5 [0.10] 9 [0.60] (a=-1.406, b=1.020)	No	No	No	No
31A	Blue Ridge Combination - Alternate Configuration	209	130	0.211	5.9 [0.33] 6.3 [0.34] 7.0 [0.33]	2 [0.25] 3 [0.25] 4 [0.25] 5 [0.25]	No	No	No	No

Table 2.5-10 Summary of Woodward-Clyde Seismic Sources

Source	Description	Distance[a] (km)	Distance[a] (mi)	Pa[b]	M_{max} (m_b) and Wts.[c]	Smoothing Options and Wts.[d]	Contributed to 99% of EPRI Hazard[e]	New Information to Suggest Change in Source: Geometry?[f]	M_{max}?[g]	RI?[h]
53	SE NY/NJ/PA NOTA Zone	247	153	0.100	5.5 [0.33] 6.3 [0.34] 6.8 [0.33]	2 [0.10] 3 [0.10] 4 [0.10] 5 [0.10] 9 [0.60] (a=-1.406, b=1.020)	No	No	No	No
22	Newark Basin	259	161	0.078	5.5 [0.33] 6.5 [0.34] 7.1 [0.33]	2 [0.10] 3 [0.10] 4 [0.10] 5 [0.10] 9 [0.60] (a=-1.503, b=0.776)	No	No	No	No
Selected Sources Beyond 200 mi (320 km)										
29	S. Carolina Gravity Saddle (Extended)	416	259	0.122	6.7 [0.33] 7.0 [0.34] 7.4 [0.33]	2 [0.25] 3 [0.25] 4 [0.25] 5 [0.25]	Yes	No	No	No
29A	SC Gravity Saddle No. 2 (Combo C3)	426	264	0.305	6.7 [0.33] 7.0 [0.34] 7.4 [0.33]	2 [0.25] 3 [0.25] 4 [0.25] 5 [0.25]	Yes	No	No	No
29B	SC Gravity Saddle No. 3 (NW Portion)	416	259	0.183	5.4 [0.33] 6.0 [0.34] 7.0 [0.33]	2 [0.25] 3 [0.25] 4 [0.25] 5 [0.25]	No	No	No	No
30	Charleston (includes NOTA)	551	342	0.573	6.8 [0.33] 7.3 [0.34] 7.5 [0.33]	2 [0.10] 3 [0.10] 4 [0.10] 5 [0.10] 9 [0.60] (a = -1.005, b = 0.852)	No	Yes; ECFS Southern Section	No	Yes; RI of 550 yrs

a. Closest Distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Smoothing options are defined as follows (from Reference 121):
1 = Low smoothing on a, high smoothing on b (no prior);
2 = High smoothing on a, high smoothing on b (no prior);
3 = High smoothing on a, high smoothing on b (moderate prior of 1.0);
4 = High smoothing on a, high smoothing on b (moderate prior of 0.9);
5 = High smoothing on a, high smoothing on b (moderate prior of 0.8);
6 = Low smoothing on a, high smoothing on b (moderate prior of 1.0);
7 = Low smoothing on a, high smoothing on b (moderate prior of 0.9);
8 = Low smoothing on a, high smoothing on b (moderate prior of0.8).
Weights on magnitude intervals are all 1.0.
9 = a and b values as listed.

e. Did the source contribute to 99% of EPRI hazard calculated at NAPS?; from Table 2.5-18.

f. No, unless new geometry proposed in literature.

g. No, unless EPRI M_{max} exceeded in literature. For Charleston, M_{max} from Reference 127 and weights even though new magnitude estimates do not generally exceed majority of EPRI M_{max} values.

h. RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed per Section 2.5.2.6.5.

Table 2.5-11 Comparison of EPRI Characterizations of the Central Virginia Seismic Zone

EPRI Team	Source	Description	Distance[a]		Pa[b]	M_{max} (m_b) and Wts.[c]	Largest M_{max} Value Considered by EPRI Team		Contributed to 99% of EPRI Hazard[d]
			km	mi			m_b	M[e]	
Bechtel	E	Central Virginia	0	0	0.35	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]	6.6	6.49	Yes
Dames & Moore	40	Central VA Seismic Zone	24	15	1.00	6.6 [0.80] 7.2 [0.20]	7.2	7.51	Yes
Law Engineering[f]	na	na	na	na	na	na	na	na	na
Rondout	29	Central VA	0	0	1.00	6.6 [0.30] 6.8 [0.60] 7.0 [0.10]	7.0	7.16	Yes
Weston	22	Central VA Seismic Zone	0	0	0.82	5.4 [0.19] 6.0 [0.65] 6.6 [0.16]	6.6	6.49	Yes
Woodward-Clyde Consultants	26	Central VA Gravity Saddle	4	3	0.434	5.4 [0.33] 6.5 [0.34] 7.0 [0.33]	7.0	7.16	Yes
Range of Largest M_{max} Value Considered by EPRI Teams = m_b 6.6 - 7.2 **M** 6.5 - 7.5									
Average of Largest M_{max} Values for 5 EPRI Teams (m_b) = 6.9									
Average of Largest M_{max} Values for 5 EPRI Teams (**M**) = 7.0									

a. Closest distance between site and source measured in Bechtel GIS system using EPRI source files.

b. Pa = probability of activity; from Reference 121

c. Maximum Magnitude (M_{max}) and weights (wts.); from Reference 121

d. Source contribution to 99% of EPRI hazard at North Anna from Table 2.5-18.

e. m_b converted from **M** as described in Section 2.5.2.2.1.

f. Law Engineering team did not define a Central VA seismic zone, but did define several mafic pluton sources in the central VA area. The seismicity parameters for the pluton sources were calculated from a large region surrounding each pluton, which effectively captured a majority of seismicity from the CVSZ, as described in Section 2.5.2.6.1.

Table 2.5-12 Seismic Source Zone Parameters from Bollinger Study (Reference 125)

							Focal Depth Distribution (km)	
Source	Description	a	b	M_{max} $m_{bLg}{}^{a}$	Ms^{a}	M^{b}	Upper Bound (D_U) 10% Quantile	Lower Bound (D_L) 90% Quantile
RZ6	Central VA	1.18	0.64	6.40	7.10	6.20	4.5	13.4
RZ3	Giles County, VA	1.07	0.64	6.30	6.80	6.06	4.4	15.1
CZ1	Complementary (Background)	2.70	0.84	5.75	5.80	5.36	3.3	18.5
LZ1	Charleston, SC	1.69	0.77	6.90	8.10	6.98	5.0	10.2
RZ4A	Eastern TN	2.72	0.90	7.35	8.75	7.78	7.6	20.8
RZ4	Eastern TN	2.72	0.90	6.45	7.15	6.27	7.6	20.8
RZ5	NW SC and SW NC	2.14	0.82	6.00	6.20	5.66	2.3	11.2
LZ3	South Carolina Piedmont and Coastal Plain	1.86	0.80	6.00	6.20	5.66	0.8	7.4
LZ4	SC Fall Line	1.58	0.81	6.25	6.50	5.99	0.9	6.1
LZ2	Bowman, SC	1.34	0.78	6.00	6.20	5.66	2.4	5.8
LZ5	Area of LZ3 minus Area of LZ4	1.70	0.80	6.00	6.20	5.66	0.9	6.5
LZ6	Savannah River Site	1.34	0.80	6.50	7.20	6.34	0.8	7.4
RZ1	New Madrid, MO (small)	3.32	0.91	7.35	8.75	7.78	3.0	11.6
RZ2	New Madrid, MO (large)	3.43	0.88	6.70	7.65	6.65	2.8	12.4

a. m_b and Ms values presented in Reference 125. The m_b to Ms conversion was defined by Nuttli in a written communication to Bollinger.

b. **M** converted from m_{bLg} as described in Section 2.5.2.6.5.

Table 2.5-13 Seismic Source Zone Parameters from Chapman and Krimgold Study (Reference 126)

Source	Description	Approx. Distance[a] km	Approx. Distance[a] mi.	Area (sq. km)	a[b]	b[b]	M_{max}[c,d] (m_{bLg})	(M)	M_{max}[e] (m_b)
1	Giles County, VA	210	130	5.1×10^3	1.07	0.64	7.25	7.53	7.22
2	Central VA	0	0	2.0×10^4	1.18	0.64	7.25	7.53	7.22
3	Eastern TN	510	317	3.7×10^4	2.72	0.90	7.25	7.53	7.22
4	Southern Appalachians (VA, NC, SC, TN)	150	93	7.6×10^4	2.42	0.84	7.25	7.53	7.22
5	Northern VA, MD	60	37	4.3×10^4	1.63	0.84	7.25	7.53	7.22
6	Central Appalachians (PA, NJ, NY)	180	112	6.8×10^4	2.84	0.98	7.25	7.53	7.22
7	Piedmont - Coastal Plain	25	16	4.4×10^5	2.32	0.84	7.25	7.53	7.22
8	Charleston, SC	570	354	1.2×10^3	1.69	0.77	7.25	7.53	7.22
9	Appalachian Foreland (TN, KY, OH, WVA, PA)	175	109	6.5×10^5	3.36	1.00	7.25	7.53	7.22
10	New Madrid, MO	1015	631	6.1×10^3	3.32	0.91	7.25	7.53	7.22

a. Closest Distance between site and source estimated (approximately) from Figure 1 in Reference 126.

b. a and b values from Reference 126.

c. Values listed in Reference 126. With the exception of New Madrid, they assumed all sources would have the same M_{max} as the largest EQ to have occurred in the southeastern U.S. region, the 1886 Charleston, SC event.

d. Note that more recent estimates of Charleston EQ magnitude are lower than **M** 7.53.
M 7.3 +0.26/-0.26 Reference 90
M 6.8 +0.3/-0.4 Reference 189

e. m_b converted from **M** as described in Section 2.5.2.2.1.

Table 2.5-14 Summary of Selected USGS Seismic Sources (Reference 127)

Description	M_{max} (M) and Wts.	Largest M_{max} Value Considered by USGS	
		M	m_b [a]
Sources within 200 mi (320 km)			
Extended Margin Background	7.5 [1.00]	7.5	7.20
Selected Sources Beyond 200 mi (320 km)			
Charleston	6.8 [0.20] 7.1 [0.20] 7.3 [0.45] 7.5 [0.15]	7.5	7.20
New Madrid	7.3 [0.15] 7.5 [0.20] 7.7 [0.50] 8.0 [0.15]	8.0	7.49
Stable Craton Background	7.0 [1.00]	7.0	6.91

a. m_b converted from **M** as described in Section 2.5.2.2.1.

Table 2.5-15 1989 EPRI PSHA Study Models

Model	Description	Weight
McGuire et al. (Reference 189)	Model developed by EPRI	0.5
Boore and Atkinson (Reference 190)	Published model	0.25
Nuttli (Reference 191)	Published model for peak parameters, combined with Newmark-Hall (Reference 192) amplification factors	0.25

Table 2.5-16 Comparison of PGA Results for North Anna Using 1989 EPRI Sources and Ground Motion Models

Ground motion (PGA)	Original 1989[a]	Replicated 1989	Difference[a]
Mean 50 cm/s^2	1.6E-3	1.62E-3	+1%
50% 50 cm/s^2	1.4E-3	1.32E-3	-5%
85% 50 cm/s^2	2.9E-3	2.92E-3	+1%
Mean 250 cm/s^2	7.0E-5	7.09E-5	+1%
50% 250 cm/s^2	4.8E-5	4.79E-5	0
85% 250 cm/s^2	1.3E-4	1.35E-4	+4%
mean 500 cm/s^2	9.3E-6	9.46E-6	+2%
50% 500 cm/s^2	5.5E-6	5.62E-6	+2%
85% 500 cm/s^2	1.7E-5	1.76E-5	+4%

a. 1989 results are only available to 2 digits accuracy in Reference 115, which could lead to a +5% apparent difference.

Table 2.5-17 Comparison of Spectral Velocity Results for North Anna Using 1989 EPRI Sources and Ground Motion Models

Parameter	Original 1989[a]	Replicated 1989	Difference
Median 1E-5 1 Hz amplitude	14.0 cm/s	14.2 cm/s	+1%
Median 1E-5 2.5 Hz amplitude	14.5 cm/s	14.5 cm/s	0%
Median 1E-5 5 Hz amplitude	13.3 cm/s	13.7 cm/s	+3%
Median 1E-5 10 Hz amplitude	10.4 cm/s	10.3 cm/s	-1%

a. Reference 115, Appendix E, Table 3-62

Table 2.5-18 Seismic Sources Contributing to 99% of Hazard for Each 1989 EPRI Team

Earth Science Team	Sources used
Bechtel	24, E, BZ4, BZ5
Dames & Moore	4, 40, 41, 42, 47, 4b, 53
Law Engineering	17, 107, 22, 217, C09, C10, C11, M19, M20, M21, M22, M23, M24, M27
Rondout Associates	28, 29, 30
Woodward-Clyde Cons.	26, 27, 29, 29A, B22
Weston Geophysical Corp.	22, C19, C21, C22, C23, C34, C35

Table 2.5-19 Significant Seismic Source at North Anna by 1989 EPRI Team

Earth Science Team	Seismic source	Description
Bechtel	E BZ5	Central VA seismic zone Local background
Dames & Moore	40	Central VA seismic zone
Law Engineering	17 M22	Eastern basement Local mafic pluton source
Rondout Association	29	Central VA seismic zone
Woodward-Clyde Consultants	27 26 B22	Central VA seismic zone Alternate Central VA seismic zone Local background
Weston Geophysical Corporation	22	Central VA seismic zone

Table 2.5-20 Controlling Earthquake Magnitude and Distances Using 1989 EPRI Sources and Ground Motion Models

	m_b	**M**[a]	r_{epi}, km	r_{CD}[b], km
Low frequency (1 and 2.5 Hz)	6.2	5.9	25	23
High frequency (5 and 10 Hz)	5.9	5.5	18	17

a. **M** converted from m_b as described in Section 2.5.2.2.1.

b. r_{CD} converted from r_{epi} as given in Reference 116, model F3.

Table 2.5-21 Spectral Amplitudes Using 1989 EPRI Sources And Ground Motion Models

Frequency	Median/Mean	1989 Ground Motions
1 Hz	10^{-5} median	0.0910 g
	10^{-5} mean	0.219 g
2.5 Hz	10^{-5} median	0.232 g
	10^{-5} mean	0.519 g
5 Hz	10^{-5} median	0.439 g
	10^{-5} mean	0.753 g
10 Hz	10^{-5} median	0.660 g
	10^{-5} mean	0.827 g

Table 2.5-22 Updated Seismic Hazard Results at ESP Site

Frequency	Median/Mean	Updated Models	1989 Models	Difference
1 Hz	10^{-5} median	0.0961 g	0.0910 g	+6%
	10^{-5} mean	0.134 g	0.219 g	-39%
2.5 Hz	10^{-5} median	0.316 g	0.232 g	+36%
	10^{-5} mean	0.364 g	0.519 g	-30%
5 Hz	10^{-5} median	0.639 g	0.439 g	+46%
	10^{-5} mean	0.735 g	0.753 g	-2%
10 Hz	10^{-5} median	1.020 g	0.660 g	+55%
	10^{-5} mean	1.216 g	0.827 g	+47%

Table 2.5-23 Controlling Earthquake Magnitude and Distances, Updated Models (Using Median 10^{-5} Ground Motion)

	m_b	**M**[a]	r_{epi}, km	r_{CD}[b], km
Low frequency (1 and 2.5 Hz)	5.9	5.6	20	19
high frequency (5 and 10 Hz)	5.7	5.3	15	15

a. **M** converted from m_b as described in Section 2.5.2.2.1.

b. r_{CD} converted from r_{epi} as given in Reference 116, model F3.

Table 2.5-24 Spectral Accelerations Corresponding to Mean 5×10^{-5} Annual Frequency

Frequency	Spectral Acceleration at 5×10^{-5}, g	Combined frequency, Hz	Average spectral Acceleration, g
1	0.0652	1.75	0.118
2.5	0.170		
5	0.339	7.5	0.443
10	0.547		

Table 2.5-25 Controlling Earthquake Magnitudes and Distances Corresponding to Mean 5×10^{-5} Annual Frequency

Frequencies	M	r_{CD}, km
Low (1 and 2.5 Hz) (using distant events only)	7.2	308
High (5 and 10 Hz)	5.4	20

Table 2.5-26 Summary of Performance-Based Spectrum Calculations

Frequency Hz	Mean 1×10^{-4} Amplitude, g	Mean 1×10^{-5} Amplitude, g	A_R	SF	A(*f*), g
0.5	0.0298	0.0944	3.17	1.51	0.0450
1	0.0463	0.134	2.89	1.40	0.0650
2.5	0.120	0.364	3.03	1.46	0.175
5	0.235	0.735	3.13	1.49	0.351
10	0.373	1.216	3.26	1.54	0.578
25	0.569	1.99	3.50	1.63	0.930
100 (PGA)	0.214	0.753	3.52	1.64	0.351

Table 2.5-27 Selected Horizontal SSE Amplitudes, V/H Ratios from Reference 171, and Resulting Vertical SSE Amplitudes

Frequency Hz	Selected Horizontal SSE Amplitudes, g	V/H Ratio	Selected Vertical SSE Amplitudes, g
100	0.374	1.00	0.374
50	0.780	1.12[a]	0.877
30	0.924	0.94[a]	0.866
25	0.930	0.88	0.818
20	0.869	0.83[a]	0.717
10	0.578	0.75	0.434
8	0.499	0.75	0.375
6	0.405	0.75	0.304
5	0.351	0.75	0.263
4	0.266	0.75	0.200
3	0.200	0.75	0.150
2.5	0.175	0.75	0.131
2	0.145	0.75	0.109
1	0.0651	0.75	0.0488
0.8	0.0581	0.75	0.0436
0.6	0.0498	0.75	0.0373
0.5	0.0450	0.75	0.0338
0.4	0.0337	0.75	0.0253
0.3	0.0229	0.75	0.0172
0.2	0.0129	0.75	0.00965
0.1	0.00412	0.75	0.00309

a. V/H ratios calculated by log-log interpretation.

Table 2.5-27A Selected Zone III-IV Control Point Horizontal SSE Amplitudes, V/H Ratios from Reference 171, and Resulting Vertical SSE Amplitudes

Frequency Hz	Selected Horizontal SSE Amplitudes, g	V/H Ratio	Selected Vertical SSE Amplitudes, g
100	0.555	1.00	0.555
50	1.195	1.12	1.33
30	1.470	0.94	1.38
25	1.476	0.88	1.29
20	1.446	0.83	1.20
10	0.945	0.75	0.708
8	0.717	0.75	0.537
6	0.481	0.75	0.360
5	0.376	0.75	0.282
4	0.287	0.75	0.215
3	0.214	0.75	0.160
2.5	0.179	0.75	0.134
2	0.142	0.75	0.106
1	0.0677	0.75	0.0507
0.8	0.0576	0.75	0.0432
0.6	0.0488	0.75	0.0366
0.5	0.0429	0.75	0.0321
0.4	0.0343	0.75	0.0257
0.3	0.0233	0.75	0.0174
0.2	0.01298	0.75	0.00973
0.1	0.00382	0.75	0.00286

Table 2.5-28 Mean 5×10^{-5} Spectral Amplitudes for RG 1.165 Reference Probability Approach and for Sensitivity Studies

Frequency	Mean 5×10^{-5} Spectral Amplitude (g), RG 1.165 RP Approach	Mean 5×10^{-5} Spectral Amplitude (g) Using Alternate M_{min}	Change From RG 1.165 RP Approach	Mean 5×10^{-5} Spectral Amplitude (g) Using Alternative Sigma	Change From RG 1.165 RP Approach
PGA	0.319	0.246	-22.9%	0.297	-6.9%
25 Hz	0.845	0.651	-23.0%	0.702	-16.9%
10 Hz	0.547	0.437	-20.1%	0.517	-5.5%
5 Hz	0.339	0.287	-15.3%	0.329	-2.9%
2.5 Hz	0.17	0.156	-8.2%	0.162	-4.7%
1 Hz	0.0652	0.0642	-1.5%	0.0592	-9.2%
0.5 Hz	0.0434	0.0428	-1.4%	0.0336	-22.6%

Table 2.5-29 Zone IIA Constituents

Location	Thickness Sampled, ft	Coarse-Grained		Fine-Grained		SC
		SP/GP	SM	ML	MH/CL/CH	
Units 1&2	2204	9.4%	67.8%	1.5%	20.3%	1%
Units 3&4	1112	17.5%	78.8%	3.7%	—[a]	—
SWR	1223	23.3%	44.7%	22.7%	6.3%	3%
ISFSI	451	—	45.5%	2.4%	47%	5.1%
ESP	105	2.4%	68.5%	20.2%	—	8.9%
Average		10.5%	61.1%	10.1%	14.7%	3.6%

Sources: Table 2.5-30 through Table 2.5-36, and Table 2.5-38

a. Dash in box denotes absence of that constituent at that location

Table 2.5-30 Summary of Units 1&2 Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	Easting	Elev.	Depth	Fill	I	IIA	IIB		Range	Median
Boring	ft	ft	ft	ft	ft	ft	ft	ft	No.	blows/ft	blows/ft
1	144,104	2,204,897	275	87	–[a]	1	35	—	7	24 to 600	138
2	144,381	2,204,733	285	97	—	3	29	—	—	—	—
3	144,667	2,204,564	279	80	—	2	33	—	—	—	—
4	144,000	2,204,665	291	104	—	—	25	—	—	—	—
5	144,175	2,204,567	294	116	—	1	20	7	—	—	—
6	144,348	2,204,464	289	110	—	1	28	—	—	—	—
7	144,559	2,204,340	275	151	—	—	55	—	—	—	—
8	143,897	2,204,438	299	97	—	1	7	—	—	—	—
9	144,176	2,204,273	281	92	—	8	55	—	—	—	—
10	144,463	2,204,108	256	79	—	2	31	—	7	17 to 1220	151
11	143,794	2,204,206	307	107	—	—	22	7	—	—	—
12	143,964	2,204,103	289	106	—	1	17	—	—	—	—
13	144,139	2,204,000	270	90	—	—	—	24	—	—	—
14	144,358	2,203,876	275	87	—	1	42	—	—	—	—
15	143,742	2,203,980	317	117	—	5	34	5	—	—	—
16	143,971	2,203,814	297	117	—	—	30	—	—	—	—
17	144,253	2,203,655	271	94	—	1	67	—	—	—	—
18	143,582	2,203,751	314	130	—	1	21	—	—	—	—
19	143,751	2,203,649	298	120	—	3	22	—	—	—	—
20	143,932	2,203,549	283	104	—	2	18	—	—	—	—
21	144,144	2,203,423	275	93	—	10	37	—	—	—	—
22	143,479	2,203,521	317	123	—	4	49	—	—	—	—
23	143,758	2,203,356	305	97	—	1	7	10	—	—	—
24	144,041	2,203,191	293	90	—	3	57	—	—	—	—
25	143,371	2,203,289	305	112	—	1	49	—	—	—	—
26	143,655	2,203,126	297	97	—	4	2	—	—	—	—
27	143,938	2,202,959	279	92	—	4	36	—	4	16 to 107	36
28	144,060	2,204,552	295	115	—	—	25	—	—	—	—

Table 2.5-30 Summary of Units 1&2 Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	Easting	Elev.	Depth	Fill	I	IIA	IIB		Range	Median
Boring	ft	ft	ft	ft	ft	ft	ft	ft	No.	blows/ft	blows/ft
29	144,129	2,204,515	294	115	—	13	7	—	—	—	—
30	144,015	2,204,418	293	92	—	—	24	—	—	—	—
31	144,036	2,204,256	281	100	—	—	7	—	—	—	—
32	143,960	2,204,294	288	109	—	—	15	—	—	—	—
34	144,297	2,204,385	286	86	—	—	45	—	—	—	—
35	144,238	2,204,136	273	75	—	—	40	5	—	—	—
36	144,206	2,204,139	272	72	—	—	60	—	—	—	—
37	144,711	2,204,201	251	65	—	—	50	—	—	—	—
38	144,675	2,204,103	244	57	—	—	40	—	—	—	—
39	143,985	2,204,582	293	112	—	—	31	15	—	—	—
40	143,892	2,204,320	297	112	—	4	11	27	—	—	—
41	143,335	2,203,820	326	77	—	—	77	—	—	—	—
42	142,737	2,204,067	305	76	—	—	76	—	—	—	—
43	143,737	2,204,722	285	60	—	2	42	8	6	69 to 140	88
44	143,119	2,204,974	275	76	—	—	76	—	—	—	—
45	143,282	2,204,569	309	76	—	—	76	—	—	—	—
46	143,167	2,204,242	317	75	—	4	71	—	—	—	—
47	143,528	2,204,284	302	76	—	—	76	—	—	—	—
48	143,020	2,204,469	294	76	—	6	70	—	—	—	—
49	144,222	2,204,490	291	120	—	—	42	—	—	—	—
50	144,123	2,204,232	287	83	—	—	53	—	9	4 to 65	9
51	144,703	2,202,598	253	20	—	—	2	—	—	—	—
52	143,765	2,202,970	285	27	—	9	18	—	—	—	—
53	144,082	2,202,414	301	27	—	19	8	—	—	—	—
54	144,402	2,201,850	300	27	—	3	24	—	—	—	—
55	144,474	2,202,231	323	27	—	9	18	—	—	—	—
101	145,187	2,203,051	282	92	—	5	36	—	—	—	—
102	142,058	2,205,639	288	100	—	—	70	15	—	—	—

Table 2.5-30 Summary of Units 1&2 Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	**Easting**	**Elev.**	**Depth**	**Fill**	**I**	**IIA**	**IIB**		**Range**	**Median**
Boring	**ft**	**ft**	**ft**	**ft**	**ft**	**ft**	**ft**	**ft**	**No.**	**blows/ft**	**blows/ft**
103	141,134	2,206,732	265	125	—	—	80	22	7	22 to 277	52
104	143,840	2,204,196	304	150	—	—	19	—	—	—	—
105	144,041	2,204,072	274	150	—	—	30	—	2	6 to 7	7
106	144,206	2,203,930	274	150	—	—	57	13	—	—	—
60			**290**	**93**	**0%**	**5%**	**89%**	**6%**	**42**		**52**
Total			**Median**		**Percentage**				**Total**		**Median**

Source: Reference 146

a. Dash in box denotes absence of that soil in boring, or no test performed.

Table 2.5-31 Summary of Units 1 & 2 Borings—Rock

Borehole Details					Top of Rock Elevation		Median Recovery/RQD					
	Northing	Easting	Depth	Elev.	III	III-IV or IV	III		III-IV		IV	
Boring	ft	ft	ft	ft	ft	ft	Rec.	RQD	Rec.	RQD	Rec.	RQD
1	144,104	2,204,897	87	275	216	239	64%	0%	87%	9%	100%	46%
2	144,381	2,204,733	97	285	–[a]	253	—	—	—	—	79%	63%
3	144,667	2,204,564	80	279	245	226	100%	52%	—	—	96%	32%
4	144,000	2,204,665	104	291	—	267	—	—	90%	0%	90%	22%
5	144,175	2,204,567	116	294	273	251	92%	70%	100%	35%	95%	55%
6	144,348	2,204,464	110	289	259	234	83%	22%	100%	86%	98%	93%
7	144,559	2,204,340	151	275	—	220	—	—	—	—	98%	62%
8	143,897	2,204,438	97	299	—	289	—	—	—	—	75%	40%
9	144,176	2,204,273	92	281	218	215	29%	25%	—	—	100%	97%
10	144,463	2,204,108	79	256	216	223	55%	33%	—	—	81%	70%
11	143,794	2,204,206	107	307	285	212	60%	0%	—	—	100%	28%
12	143,964	2,204,103	106	289	—	268	—	—	—	—	97%	80%
13	144,139	2,204,000	90	270	246	240	22%	0%	91%	75%	100%	85%
14	144,358	2,203,876	87	275	225	211	30%	0%	—	—	90%	70%
15	143,742	2,203,980	117	317	278	249	50%	20%	—	—	93%	82%
16	143,971	2,203,814	117	297	—	267	—	—	—	—	100%	90%
17	144,253	2,203,655	94	271	—	203	—	—	—	—	100%	97%
18	143,582	2,203,751	130	314	292	225	10%	0%	—	—	87%	60%
19	143,751	2,203,649	120	298	273	234	25%	8%	—	—	75%	66%
20	143,932	2,203,549	104	283	263	245	33%	16%	—	—	95%	88%
21	144,144	2,203,423	93	275	235	206	25%	0%	—	—	96%	66%
22	143,479	2,203,521	123	317	264	254	43%	15%	57%	11%	91%	44%
23	143,758	2,203,356	97	305	287	274	76%	56%	—	—	95%	78%
24	144,041	2,203,191	90	293	—	233	—	—	—	—	80%	71%
25	143,371	2,203,289	112	305	255	205	0%	0%	—	—	100%	73%
26	143,655	2,203,126	97	297	291	288	96%	65%	—	—	70%	59%
27	143,938	2,202,959	92	279	239	210	17%	0%	—	—	78%	40%

Table 2.5-31 Summary of Units 1 & 2 Borings—Rock

Borehole Details					Top of Rock Elevation		Median Recovery/RQD					
	Northing	Easting	Depth	Elev.	III	III-IV or IV	III		III-IV		IV	
Boring	ft	ft	ft	ft	ft	ft	Rec.	RQD	Rec.	RQD	Rec.	RQD
28	144,060	2,204,552	115	295	—	270	—	—	100%	25%	100%	38%
29	144,129	2,204,515	115	294	—	274	—	—	100%	63%	—	—
30	144,015	2,204,418	92	293	—	269	—	—	100%	60%	100%	77%
31	144,036	2,204,256	100	281	274	230	80%	42%	47%	17%	90%	47%
32	143,960	2,204,294	109	288	—	273	—	—	—	—	97%	50%
34	144,297	2,204,385	86	286	206	241	62%	9%	—	—	80%	47%
35	144,238	2,204,136	75	273	233	—	50%	29%	—	—	—	—
36	144,206	2,204,139	72	272	—	212	—	—	75%	42%	—	—
37	144,711	2,204,201	65	251	—	201	—	—	—	—	75%	43%
38	144,675	2,204,103	57	244	—	204	—	—	—	—	67%	32%
39	143,985	2,204,582	112	293	243	262	90%	42%	67%	18%	88%	70%
40	143,892	2,204,320	112	297	282	228	70%	21%	49%	4%	—	—
41	143,335	2,203,820	77	326	—	—	—	—	—	—	—	—
42	142,737	2,204,067	76	305	—	—	—	—	—	—	—	—
43	143,737	2,204,722	60	285	—	—	—	—	—	—	—	—
44	143,119	2,204,974	76	275	—	—	—	—	—	—	—	—
45	143,282	2,204,569	76	309	—	—	—	—	—	—	—	—
46	143,167	2,204,242	75	317	—	—	—	—	—	—	—	—
47	143,528	2,204,284	76	302	—	—	—	—	—	—	—	—
48	143,020	2,204,469	76	294	—	—	—	—	—	—	—	—
49	144,222	2,204,490	120	291	—	249	—	—	83%	62%	85%	33%
50	144,123	2,204,232	83	287	—	234	—	—	—	—	95%	92%
51	144,703	2,202,598	20	253	251	—	65%	17%	—	—	—	—
52	143,765	2,202,970	27	285	—	—	—	—	—	—	—	—
53	144,082	2,202,414	27	301	—	—	—	—	—	—	—	—
54	144,402	2,201,850	27	300	—	—	—	—	—	—	—	—
55	144,474	2,202,231	27	323	—	—	—	—	—	—	—	—

Table 2.5-31 Summary of Units 1 & 2 Borings—Rock

Borehole Details					Top of Rock Elevation		Median Recovery/RQD					
	Northing	Easting	Depth	Elev.	III	III-IV or IV	III		III-IV		IV	
Boring	ft	ft	ft	ft	ft	ft	Rec.	RQD	Rec.	RQD	Rec.	RQD
101	145,187	2,203,051	92	282	242	236	83%	40%	—	—	82%	62%
102	142,058	2,205,639	100	288	—	—	—	—	—	—	—	—
103	141,134	2,206,732	125	265	—	—	—	—	—	—	—	—
104	143,840	2,204,196	150	304	—	298	—	—	55%	17%	100%	88%
105	144,041	2,204,072	150	274	244	242	80%	67%	—	—	92%	79%
106	144,206	2,203,930	150	274	216	204	57%	4%	96%	40%	100%	95%
60			**5589**	**290**	**250**	**236**	**58%**	**18%**	**88%**	**30%**	**92%**	**66%**
Total			**Total**	**Median**								

Source: Reference 146

a. Dash in box denotes absence of that rock in boring, and no Recovery/RQD recorded.

Table 2.5-32 Summary of Units 3 & 4 Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	Easting	Elev.	Depth	Fill	I	IIA	IIB		Range	Median
Boring	ft	ft	ft	ft	ft	ft	ft	ft	No.	blows/ft	blows/ft
601	144,563	2,203,695	269	64	5	—	19	—	2	16 to 100	58
602	144,490	2,203,510	277	70	21	—	—	—	—	—	—
603	144,495	2,203,615	274	85	14	—	19	20	2	105 to 175	140
604	144,500	2,203,731	270	85	3	—	16	10	1	40	40
605	144,425	2,203,535	277	70	15	—	14	—	3	35 to 123	54
606	144,338	2,203,843	270	70	2	—	22	11	4	18 to 140	48
607	144,235	2,203,570	270	65	2	—	26	7	5	13 to 250	32
608	144,270	2,203,882	270	87	2	—	33	37	3	31 to 146	143
609	144,232	2,203,803	271	90	2	—	54	7	5	13 to 140	21
610	144,188	2,203,705	271	96	2	—	70	9	8	22 to 225	27
611	144,165	2,203,610	271	76	2	—	48	—	5	15 to 220	33
612	144,125	2,203,515	270	80	7	—	46	5	1	13	13
613	144,195	2,203,910	270	65	2	—	42	—	7	15 to 90	30
614	144,160	2,203,825	271	70	2	—	38	—	5	18 to 33	23
615	144,125	2,203,723	270	65	2	—	33	4	4	12 to 44	28
616	144,100	2,203,638	271	64	1	—	32	—	5	9 to 45	24
617	144,063	2,203,548	271	70	2	—	38	5	7	26 to 136	94
618	144,140	2,203,930	270	54	2	—	32	—	5	14 to 44	32
619	144,065	2,203,749	271	49	1	—	12	—	2	65 to 110	87
620	144,108	2,203,859	270	46	1	—	9	3	1	40	40
621	144,005	2,203,700	271	50	–[a]	—	2	—	—	—	—
622	143,510	2,203,535	271	79	1	—	19	10	3	41 to 360	210
623	143,915	2,203,670	272	79	2	—	12	—	2	49 to 510	275
624	143,960	2,203,985	271	175	1	—	9	—	2	49 to 150	100
625	143,905	2,203,845	270	40	5	—	—	—	1	6	6
626	143,870	2,203,686	272	150	1	—	7	—	1	119	119
627	143,911	2,204,068	271	78	3	—	7	—	—	—	—

Table 2.5-32 Summary of Units 3 & 4 Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	Easting	Elev.	Depth	Fill	I	IIA	IIB		Range	Median
Boring	ft	ft	ft	ft	ft	ft	ft	ft	No.	blows/ft	blows/ft
628	143,878	2,203,980	271	78	3	—	—	—	—	—	—
629	143,795	2,203,780	272	79	1	—	—	—	—	—	—
630	143,775	2,203,725	271	78	3	—	—	—	—	—	—
631	143,345	2,204,005	322	105	—	11	77	—	8	13 to 262	48
632	143,815	2,204,355	294	75	1	—	15	18	3	44 to 116	56
633	143,880	2,204,570	284	59	8	—	5	15	—	—	—
634	143,945	2,204,790	284	62	8	—	25	8	5	23 to 145	65
635	143,995	2,204,960	275	65	-	2	19	18	—	—	—
636	144,415	2,203,750	270	70	3	—	26	15	5	15 to 400	200
637	144,340	2,203,570	271	75	10	—	20	—	3	14 to 200	42
638	144,660	2,203,660	268	50	3	—	5	20	1	116	116
639	144,590	2,203,475	274	61	23	—	8	10	2	128 to 160	144
640	144,290	2,203,935	269	82	-	—	47	35	8	22 to 242	50
641	143,205	2,203,855	270	88	2	—	55	—	10	16 to 300	28
642	144,175	2,203,655	271	75	2	—	52	—	7	19 to 94	26
643	144,109	2,203,586	270	72	2	—	30	8	6	18 to 400	55
644	143,825	2,203,745	271	50	5	—	-	—	—	—	—
645	143,895	2,204,010	271	78	5	—	-	—	—	—	—
646	144,665	2,203,790	268	47	8	—	39	—	8	20 to 240	68
647	144,705	2,203,430	256	40	—	—	28	—	5	13 to 200	44
47			**271**	**71**	**12%**	**1%**	**71%**	**16%**	**155**	**—**	**50**
Total			**Median**		**Percentage**				**Total**		**Median**

Source: Reference 8

a. Dash in box denotes absence of that soil in boring, or no test performed.

Table 2.5-33 Summary of Units 3 & 4 Borings—Rock

Borehole Details					Top of Rock El.		Median Recovery/RQD					
	Northing	Easting	Depth	Elev.	III	IV or III-IV	III		III-IV		IV	
Boring	ft	ft	ft	ft	ft	ft	Rec.	RQD	Rec.	RQD	Rec.	RQD
601	144,563	2,203,695	64	269	237	245	98%	39%	95%	73%	—	—
602	144,490	2,203,510	70	277	238	255	84%	30%	69%	29%	—	—
603	144,495	2,203,615	85	274	209	230	57%	6%	100%	50%	100%	85%
604	144,500	2,203,731	85	270	251	190	75%	27%	—	—	100%	69%
605	144,425	2,203,535	70	277	248	—	98%	45%	—	—	—	—
606	144,338	2,203,843	70	270	205	223	20%	0%	100%	60%	—	—
607	144,235	2,203,570	65	270	235	227	—	—	100%	55%	—	—
608	144,270	2,203,882	87	270	235	188	75%	23%	—	—	93%	49%
609	144,232	2,203,803	90	271	208	—	87%	14%	—	—	—	—
610	144,188	2,203,705	96	271	–[a]	191	—	—	100%	86%	—	—
611	144,165	2,203,610	76	271	—	221	—	—	—	—	97%	96%
612	144,125	2,203,515	80	270	—	212	—	—	—	—	98%	75%
613	144,195	2,203,910	65	270	226	—	100%	51%	—	—	—	—
614	144,160	2,203,825	70	271	231	224	70%	5%	93%	55%	97%	69%
615	144,125	2,203,723	65	270	232	227	—	—	78%	60%	—	—
616	144,100	2,203,638	64	271	238	227	67%	53%	95%	83%	—	—
617	144,063	2,203,548	70	271	226	221	96%	44%	—	—	94%	94%
618	144,140	2,203,930	54	270	—	236	—	—	—	—	100%	90%
619	144,065	2,203,749	49	271	249	258	92%	0%	—	—	93%	93%
620	144,108	2,203,859	46	270	259	257	—	—	—	—	99%	77%
621	144,005	2,203,700	50	271	269	246	69%	65%	—	—	100%	100%
622	143,510	2,203,535	79	271	246	241	75%	10%	—	—	100%	84%
623	143,915	2,203,670	79	272	258	234	80%	35%	—	—	100%	87%
624	143,960	2,203,985	175	271	—	261	—	—	—	—	98%	80%
625	143,905	2,203,845	40	270	—	265	—	—	—	—	100%	90%
626	143,870	2,203,686	150	272	—	264	—	—	94%	40%	98%	91%
627	143,911	2,204,068	78	271	261	246	75%	20%	100%	66%	100%	91%
628	143,878	2,203,980	78	271	258	242	90%	9%	100%	61%	100%	90%

Table 2.5-33 Summary of Units 3 & 4 Borings—Rock

Borehole Details					Top of Rock El.		Median Recovery/RQD					
	Northing	Easting	Depth	Elev.	III	IV or III-IV	III		III-IV		IV	
Boring	ft	ft	ft	ft	ft	ft	Rec.	RQD	Rec.	RQD	Rec.	RQD
629	143,795	2,203,780	79	272	269	262	50%	20%	100%	80%	100%	90%
630	143,775	2,203,725	78	271	268	251	100%	58%	100%	75%	100%	75%
631	143,345	2,204,005	105	322	—	234	—	—	52%	28%	—	—
632	143,815	2,204,355	75	294	262	—	80%	70%	—	—	—	—
633	143,880	2,204,570	59	284	257	229	70%	15%	100%	50%	—	—
634	143,945	2,204,790	62	284	251	—	96%	60%	—	—	—	—
635	143,995	2,204,960	65	275	224	236	86%	23%	—	—	86%	52%
636	144,415	2,203,750	70	270	241	—	60%	18%	—	—	—	—
637	144,340	2,203,570	75	271	241	227	65%	35%	50%	29%	85%	81%
638	144,660	2,203,660	50	268	—	239	—	—	75%	35%	—	—
639	144,590	2,203,475	61	274	232	218	70%	8%	—	—	85%	50%
640	144,290	2,203,935	82	269	222	—	95%	39%	—	—	-	-
641	143,205	2,203,855	88	270	214	197	75%	35%	—	—	100%	73%
642	144,175	2,203,655	75	271	217	208	100%	20%	—	—	98%	70%
643	144,109	2,203,586	72	270	230	218	60%	40%	90%	70%	-	-
644	143,825	2,203,745	50	271	266	256	93%	31%	90%	30%	-	-
645	143,895	2,204,010	78	271	—	266	—	—	100%	40%	100%	68%
646	144,665	2,203,790	47	268	—	—	—	—	—	—	—	—
647	144,705	2,203,430	40	256	228	—	80%	25%	—	—	—	—
47			**3461**	**271**	**238**	**234**	**80%**	**27%**	**95%**	**60%**	**100%**	**82%**
Total			**Total**	**Median**								

Source: Reference 8

a. Dash in box denotes absence of that rock in boring, and no Recovery/RQD recorded.

Table 2.5-34 Summary of Service Water Reservoir Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	Easting	Elev.	Depth	Fill	I	IIA	IIB		Range	Median
Boring	ft	ft	ft	ft	ft	ft	ft	ft	No.	blows/ft	blows/ft
P-10	142,876	2,204,869	283	27	–[a]	—	27	—	4	20 to 142	34
P-11	143,495	2,204,410	324	53	13	—	40	—	7	13 to 23	16
P-12	143,561	2,204,416	298	30	—	—	30	—	4	17 to 25	18
P-15	143,150	2,204,700	321	72	28	—	44	—	1	19	19
P-16	143,050	2,204,607	321	70	32	—	38	—	7	18 to 107	28
P-17	142,958	2,204,529	321	77	32	—	45	—	9	17 to 137	22
S1-1	143,495	2,204,430	326	92	12	—	80	—	12	17 to 100	26
S1-2	143,565	2,204,435	297	75	—	—	75	—	7	15 to 100	33
S1-3	143,078	2,204,777	285	64	—	—	64	—	9	31 to 155	63
SWR-1	143,470	2,204,492	306	58	—	—	43	15	27	9 to 24	17
SWR-2	143,438	2,204,492	306	58	—	—	50	8	33	11 to 84	18
SWR-3	143,076	2,203,686	321	100	—	—	100	—	19	12 to 142	45
SWR-4	143,396	2,203,983	320	101	—	—	101	—	20	16 to 400	30
SWR-5	143,391	2,204,753	321	105	26	—	79	—	17	12 to 226	23
SWR-6	143,127	2,204,712	321	104	15	—	89	—	18	16 to 400	25
SWR-7	142,942	2,204,532	321	82	15	—	67	—	13	8 to 37	19
SWR-8	142,951	2,204,302	321	72	10	—	62	—	13	9 to 109	25
SWR-9	142,982	2,204,061	321	67	12	—	55	—	11	8 to 274	50
SWR-10	143,133	2,204,685	321	64	31	—	33	—	13	14 to 36	21
SWR-11	142,980	2,204,685	286	38	16	—	22	—	5	17 to 300	48
SWR-12	142,893	2,204,598	289	49	15	—	34	—	—	—	—
SWR-13	143,242	2,204,792	321	72	27	—	45	—	9	13 to 62	22
22			**321**	**71**	**18.5%**	**0**	**80%**	**1.5%**	**258**		**25**
Total			**Median**		**Percentage**				**Total**		**Median**

Source: Reference 5

a. Dash in box denotes absence of that soil in boring, or no test performed.

Table 2.5-35 Summary of Service Water Reservoir Borings—Rock

Borehole Details					Top of Rock Elev.[a]	
	Northing	**Easting**	**Depth**	**Elev.**	**III**	**III-IV or IV**
Boring	**ft**	**ft**	**ft**	**ft**	**ft**	**ft**
P-10	142,876	2,204,869	27	283	–[b]	—
P-11	143,495	2,204,410	53	324	—	—
P-12	143,561	2,204,416	30	298	—	—
P-15	143,150	2,204,700	72	321	—	—
P-16	143,050	2,204,607	70	321	—	—
P-17	142,958	2,204,529	77	321	—	—
S1-1	143,495	2,204,430	92	326	—	234
S1-2	143,565	2,204,435	75	297	—	222
S1-3	143,078	2,204,777	64	285	—	221
SWR-1	143,470	2,204,492	58	306	248	—
SWR-2	143,438	2,204,492	58	306	248	—
SWR-3	143,076	2,203,686	100	321	—	221
SWR-4	143,396	2,203,983	101	320	—	219
SWR-5	143,391	2,204,753	105	321	—	216
SWR-6	143,127	2,204,712	104	321	—	217
SWR-7	142,942	2,204,532	82	321	—	—
SWR-8	142,951	2,204,302	72	321	—	—
SWR-9	142,982	2,204,061	67	321	—	—
SWR-10	143,133	2,204,685	64	321	—	—
SWR-11	142,980	2,204,685	38	286	—	—
SWR-12	142,893	2,204,598	49	289	—	—
SWR-13	143,242	2,204,792	72	321	—	—
22			**1530**	**321**	**248**	**221**
Total			**Total**	**Median**		

Source: Reference 5

a. Top of rock is estimated since there was no rock coring.

b. Dash in box denotes absence of that rock in boring.

Table 2.5-36 Summary of ISFSI Borings—Soils

Borehole Details					Soil Zone Thickness				Zone IIA N-Values		
	Northing	Easting	Elev.	Depth	Fill	I	IIA	IIB		Range	Median
Boring	ft	ft	ft	ft	ft	ft	ft	ft	No.	blows/ft	blows/ft
F-2	142,000	2,202,990	320	70	–[a]	—	65	—	14	14 to 78	18
F-4	141,982	2,202,850	317	59	—	—	34	15	9	15 to 125	21
F-5	141,982	2,203,200	318	115	—	—	64	—	15	9 to 44	25
F-6	141,864	2,202,850	316	59	—	—	44	—	11	13 to 110	19
F-7	141,864	2,203,000	320	105	—	—	75	—	18	10 to 165	21
F-8	141,864	2,203,200	318	69	—	—	35	29	9	16 to 36	24
F-9	141,746	2,202,850	311	105	—	—	55	4	13	7 to 56	21
F-10	141,746	2,203,000	315	74	—	—	50	19	12	20 to 80	27
F-11	141,746	2,203,200	309	69	—	—	29	10	8	32 to 160	42
9			**317**	**70**	**0**	**0**	**85.4**	**14.6**	**109**		**21**
Total			**Median**		**Percentage**				**Total**		**Median**

Source: Reference 6

a. Dash in box denotes absence of that soil in boring, or no test performed.

Table 2.5-37 Summary of ISFSI Borings—Rock

Borehole Details					Top of Rock Elev.	Avg. Recovery/ RQD	
	Northing	Easting	Depth	Elev.	III	III	
Boring	ft	ft	ft	ft	ft	Rec.	RQD
F-2	142,000	2,202,990	70	320	255	0%	0%
F-4	141,982	2,202,850	59	317	268	50%	20%
F-5	141,982	2,203,200	115	318	254	15%	0%
F-6	141,864	2,202,850	59	316	272	23%	6%
F-7	141,864	2,203,000	105	320	245	11%	0%
F-8	141,864	2,203,200	69	318	254	80%	0%
F-9	141,746	2,202,850	105	311	252	20%	4%
F-10	141,746	2,203,000	74	315	246	95%	36%
F-11	141,746	2,203,200	69	309	260	41%	8%
9			**725**	**317**	**254**	**23%**	**4%**
Total			**Total**	**Median**			

Source: Reference 5

Table 2.5-38 Summary of ESP Borings, Observation Wells, and CPTs—Soils

Borehole/OW/CPT Details					Soil Zone Thickness				IIA N-Values		
Boring/ OW/CPT	**Northing ft**	**Easting ft**	**Elev. ft**	**Depth ft**	**Fill ft**	**I ft**	**IIA ft**	**IIB ft**	**No.**	**Range blows/ft**	**Median blows/ft**
B-801	144,034	2,203,740	249	50	19	—	—	—	—	—	—
B-802	143,639	2,203,383	271	90	3	—	3	—	1	44	44
B-803	143,603	2,202,766	292	170	–[a]	—	31	—	9	12 to 31	22
B-804	143,179	2,202,137	320	60	—	2	21	—	8	5 to 24	8
B-805	144,043	2,203,249	271	90	—	—	23	5	8	12 to 100	22
B-806	143,098	2,200,979	299	65	2	—	6	—	2	18 to 22	20
B-807	143,530	2,200,983	311	72	—	—	21	21	10	12 to 100	16
7			**292**	**72**	**15%**	**1%**	**67%**	**17%**	**38**	—	**21**
Total			**Median**		**Percentage**				**Total**		**Median**
					Soil Thickness, ft						
OW-841	144,238	2,203,806	252	34	24						
OW-842	142,716	2,202,151	337	50	50						
OW-843	143,407	2,202,059	321	49	49						
OW-844	143,591	2,203,592	274	25	24						
OW-845	143,540	2,202,743	297	55	33						
OW-846	143,527	2,202,724	297	33	33						
OW-847	142,627	2,203,450	320	50	50						
OW-848	144,535	2,203,275	285	47	33						
OW-849	144,468	2,201,733	299	50	50						
9			**297**	**49**	**33**						
Total			**Median**								
CPT-821	143,647	2,203,355	271	4	4						
CPT-822	144,057	2,203,239	271	23	23						
CPT-823	143,532	2,202,758	296	32	32						
CPT-824	143,736	2,203,012	276	4	4						
CPT-825	143,160	2,202,269	333	52	52						
CPT-827	144,370	2,200,571	277	58	58						
CPT-828	144,334	2,200,068	270	5	5						
CPT-830	143,531	2,203,002	308	16	16						
8			**276**	**20**	**20**						
Total			**Median**								

Source: Reference 147

a. Dash in box denotes absence of that soil in boring, or no test performed.

Table 2.5-39 Summary of ESP Borings, Observation Wells, and CPTs—Rock

Borehole/OW/CPT Details					Top of Rock Elev.		Median Recovery/RQD					
							III		III-IV		IV	
Boring/ OW/CPT	Northing ft	Easting ft	Depth ft	Elev. ft	III ft	III-IV or IV ft	Rec.	RQD	Rec.	RQD	Rec.	RQD
B-801	144,034	2,203,740	50	249	230	229	–[a]	—	—	—	100%	100%
B-802	143,639	2,203,383	90	271	265	263	—	—	88%	44%	100%	84%
B-803	143,603	2,202,766	170	292	262	244	—	—	—	—	100%	100%
B-804	143,179	2,202,137	60	320	298	287	—	—	80%	47%	100%	98%
B-805	144,043	2,203,249	90	271	243	232	—	—	90%	70%	100%	90%
B-806	143,098	2,200,979	65	299	292	288	25%	5%	86%	65%	—	—
B-807	143,530	2,200,983	72	311	276	254	—	—	46%	0%	—	—
7			**597**	**292**	**265**	**254**	**25%**	**5%**	**86%**	**47%**	**100%**	**98%**
Total			**Total**	**Median**								
OW-841	144,238	2,203,806	34	252	228							
OW-842	142,716	2,202,151	50	337	—							
OW-843	143,407	2,202,059	49	321	—							
OW-844	143,591	2,203,592	25	274	250							
OW-845	143,540	2,202,743	55	297	264							
OW-846	143,527	2,202,724	33	297	—							
OW-847	142,627	2,203,450	50	320	—							
OW-848	144,535	2,203,275	47	285	252							
OW-849	144,468	2,201,733	50	299	—							
9			**393**	**297**	**251**							
Total			**Total**	**Median**								
CPT-821	143,647	2,203,355	4	271								
CPT-822	144,057	2,203,239	23	271								
CPT-823	143,532	2,202,758	32	296								
CPT-824	143,736	2,203,012	4	276								
CPT-825	143,160	2,202,269	52	333								
CPT-827	144,370	2,200,571	58	277								
CPT-828	144,334	2,200,068	5	270								
CPT-830	143,531	2,203,002	16	308								
8			**194**	**276**								
Total			**Total**	**Median**								

a. Dash in box denotes absence of that soil in boring, or no test performed. Source: Reference 147.

Table 2.5-40 Summary of Soil Sampling Results

Location	No. of Boreholes	Borehole Median, ft			Percentage per Zone				Zone IIA N-Values	
		Elevation	Total Depth	Soil Thickness	Fill %	I %	IIA %	IIB %	Number	Median blows/ft
Units 1&2	60	290	93	40	0	5	89	6	42	52
Units 3&4	47	271	71	34	12	1	71	16	155	50
SWR	22	321	71	71	18	0	80	2	258	25
ISFSI	9	317	70	64	0	0	85	15	109	21
ESP	7	292	72	23	15	1	67	17	38	21

Sources: Reference 5, Reference 6, Reference 146, Reference 8 and Reference 147

Table 2.5-41 Summary of Rock Coring Results

Location	III			III-IV			IV		
	Thickness ft	Recovery %	RQD %	Thickness ft	Recovery %	RQD %	Thickness ft	Recovery %	RQD %
Units 1&2	702	58	18	493	88	30	1896	92	66
Units 3&4	647	88	27	491	95	60	732	100	82
ISFSI	197	23	4	–[a]	–	–	–	–	–
ESP	94	25	5	91	86	47	255	100	98

Sources: Reference 6, Reference 146, Reference 8 and Reference 147

a. Dash in box denotes absence of that rock in boring, or no recovery/RQD recorded.

Table 2.5-42 Summary of Laboratory Tests Performed

Test	Units 1 & 2	SWR	ISFSI	ESP	Total
Soil					
Moisture content	72	339	30	9	**450**
Percent passing #200 sieve	—[a]	260	-	-	**260**
Sieve analysis	15	63	19	10	**107**
Sieve and hydrometer analysis	-	4	-	5	**9**
Atterberg limits [b]	4	16	13	5	**38**
Unit weight	71	163	11	-	**245**
Mineral analysis (thin section)	1	27	-	-	**28**
Permeability	4	-	1	-	**5**
pH	2	-	-	4	**6**
Sulfate	2	-	-	4	**6**
Chloride	-	-	-	4	**4**
Moisture density (Proctor)	2	-	3	-	**5**
CBR	-	-	3	-	**3**
Consolidation	5	15[c]	3	-	**23**
Unconfined compression	2	-	5	-	**7**
Triaxial compression (UU)	19[d]	62	5	-	**86**
Triaxial compression (CIU) w/pp	5	8	6	-	**19**
Triaxial compression (cyclic)	2	15	-	-	**17**
Direct shear	-	2	-	-	**2**
Shockscope	3	-	-	-	**3**
Rock					
Unit weight	-	-	-	19	**19**
Unconfined compression	24	-	-	13	**37**
Unconfined compression w/stress-strain	6	-	-	6	**12**

Sources: Reference 5, Reference 6, Reference 146, Reference 8 and Reference 147.

a. Dash denotes no test performed.

b. Atterberg limit tests only listed for plastic samples tested.

c. Includes 5 constant strain tests with pore pressure measurement.

d. Includes 8 tests on prepared soil samples.

Table 2.5-43 Summary of ESP Laboratory Test Results

Sample Identification			Moisture Content %	Atterberg Limits			% Finer #200 Sieve	Chemical Tests		
Boring	Sample Number	Depth ft		Liquid Limit	Plastic Limit	Plasticity Index		pH	Chlorides mg/kg	Sulfates Mg/kg
B-801	SS-1	0-1.5	22.2	39	29	10		6.3	130	<27
B-801	SS-5	8.5-10	–[a]	—	—	—	39.9	—	—	—
B-801	SS-6	13.5-15	—	—	—	—	55.1	—	—	—
B-802	SS-2	3.7-5.2	—	—	—	—	19.5	—	—	—
B-803	SS-3	6.1-7.6	18.9	30	26	4	-	—	—	—
B-803	SS-4	8.6-10.1	23.2	—	—	—	24.4	—	—	—
B-803	SS-6	13.7-15.3	—	—	—	—	20.9	5.7	100	<23
B-803	SS-8	23.6-25.1	—	—	—	—	18.5	—	—	—
B-804	SS-3	3.5-5	—	—	—	—	54.2	—	—	—
B-804	SS-6	11-12.5	—	—	—	—	46.1	—	—	—
B-804	SS-8	18.5-20	—	—	—	—	22.1	—	—	—
B-805	SS-4	7.5-9	27.2	NP[b]	NP	NP	27.5	—	—	—
B-805	SS-7	18.5-20	—	—	—	—	25.1	—	—	—
B-806	SS-3	5.6-7.1	—	—	—	—	27.1	6.7	920	<24
B-807	SS-3	4.5-6	40.1	49	45	4	—	—	—	—
B-807	SS-6	12.3-13.8	42.8	46	40	6	—	5.7	170	<28
B-807	SS-8	21.8-23.8	28.9	41	34	7	42.6	—	—	—
B-807	SS-10	31.5-33	26.7	—	—	—	37.7	—	—	—
B-807	SS-12	41.4-42.9	21.8	—	—	—	44.2	—	—	—
Source: Reference 147										

a. Dash denotes no test performed.

b. NP – Non Plastic

Table 2.5-44 Summary of ESP Laboratory Test Results—Rock

Boring Number	Depth, ft	Zone	Unconfined Compressive Strength, ksi	Modulus of Elasticity, ksi	Poisson's Ratio
B-801	24.1-24.8	IV	27.21	–[a]	—
B-801	48.7-49.7	IV	28.42	8670	0.27
B-802	20.4-21.0	III-IV	8.64	—	—
B-802	44.9-45.6	IV	11.76	—	—
B-802	66.0-66.7	IV	14.71	4613	0.24
B-802	85.3-85.9	IV	9.37	—	—
B-803	54.1-54.7	IV	13.01	—	—
B-803	70.4-71.1	IV	23.21	7133	0.34
B-803	90.3-91.0	IV	27.59	—	—
B-803	129.4-130.1	IV	26.73	—	—
B-803	155.6-156.4	IV	22.03	7173	0.33
B-804	38.9-39.9	IV	27.15	—	—
B-804	43.5-44.9	IV	25.20	—	—
B-804	49.9-50.5	IV	12.30	3190	0.43
B-805	41.3-41.9	III-IV	3.40	336	0.15
B-805	80.8-81.6	IV	4.43	—	—
B-806	25.1-25.8	III	0.61	—	—
B-806	42.6-43.2	III-IV	2.72	—	—
B-806	64.1-64.5	IV	27.36	—	—

Source: Reference 147

a. Dash denotes no test performed.

Table 2.5-45 Summary of Geotechnical Engineering Properties

Stratum	IIA		IIB	III	III-IV	IV
	Coarse-grained	Fine-grained				
Description	Saprolite	Saprolite	Saprolite w/10 to 50% Core Stone	Moderately to Highly Weathered Quartz Gneiss w/Biotite	Slightly to Moderately Weathered Quartz Gneiss w/Biotite	Fresh to Slightly Weathered Quartz Gneiss w/Biotite
Rock properties						
Recovery,%	—	—	—	60	90	100
RQD,%	—	—	—	20	50	95
Unconfined compressive strength, ksi	—		—	0.6	4	12
USCS symbol	SP, SM, SC	ML, CL, MH, CH	Mainly SM	—	—	—
Range of fines content,%	15 to 45	—	—	—	—	—
Natural moisture content, w,%	—	26	—	—	—	—
Undrained shear strength, c_u, ksf	—	2.0	—	—	—	—
Effective cohesion, c', ksf	0.25	0.5	—	—	—	—
Effective friction angle, ϕ', degrees	30	25	40	—	—	—
Total unit weight, γ, pcf	125		130	145	163	163
SPT N-value, N_{60}, blows/ft	20		100	—	—	—
Shear and compression wave velocity						
Shear wave velocity range, ft/sec	600 to 1350		No range available	1500 to 2500	2500 to 4500	4000 to 8000
Shear wave velocity best estimate, ft/sec	950		1600	2000	3300	6300
Compression wave velocity best estimate, ft/sec	2100		3500	4500	7400	14,000

Table 2.5-45 Summary of Geotechnical Engineering Properties

Stratum	IIA		IIB	III	III-IV	IV
	Coarse-grained	Fine-grained				
Description	Saprolite	Saprolite	Saprolite w/10 to 50% Core Stone	Moderately to Highly Weathered Quartz Gneiss w/Biotite	Slightly to Moderately Weathered Quartz Gneiss w/Biotite	Fresh to Slightly Weathered Quartz Gneiss w/Biotite
Elastic and shear moduli						
Elastic modulus (high strain), E_{hs}	1200 ksf		3500 ksf	120 ksi	1000 ksi	3750 ksi
Elastic modulus (low strain), E_{ls}	9500 ksf		28,000 ksf	300 ksi	1000 ksi	3750 ksi
Shear modulus (high strain), G_{hs}	450 ksf		1300 ksf	50 ksi	375 ksi	1400 ksi
Shear modulus (low strain), G_{ls}	3500 ksf		10,000 ksf	125 ksi	375 ksi	1400 ksi
Consolidation characteristics						
Recompression ratio, RR	0.015		—	—	—	—
Coeff. of secondary compression, C_{α}	0.0008		—	—	—	—
Coeff. of subgrade reaction, k_1, kcf	230		1500	-	-	-
Coefficient of sliding against concrete	0.35		0.45	0.6	0.65	0.7
Poisson's ratio, μ (high strain)	0.35		0.3	0.33	0.33	0.33
Static earth pressure coefficients						
Active, K_a	0.33		0.22	—	—	—
Passive, K_p	3.0		4.6	—	—	—
At-rest, K_o	0.5		0.36	—	—	—
Hydraulic conductivity, cm/sec	5×10^{-4}		—	—	—	—

Note:Dash denotes no design parameter given

Table 2.5-46 ZPA Results from SHAKE Analysis

		Profile 1					
Depth, ft	V_s, ft/sec	G_{max}	150% G_{max}	Profile 2	Profile 3	V_s, ft/sec	Profile 4
			Low Frequency Case				
0.0	700	0.458g	0.567g	–[a]	–	1275	0.415g
2.5	700	0.394g	0.503g	–	–	1275	0.396g
5.0	700	0.328g	0.357g	–	–	1275	0.338g
7.5	700	0.314g	0.329g	–	–	1275	0.247g
10.0	700/950	0.255g	0.283g	–	–	1275/1380	0.245g
12.5	950	0.286g	0.268g	–	–	1380	0.239g
15.0	950	0.272g	0.273g	–	–	1380	0.224g
17.5	950	0.323g	0.228g	–	–	1380	0.212g
20.0	950/1200	0.300g	0.269g	–	–	1380/1500	0.199g
22.5	1200	0.265g	0.294g	–	–	1500	0.205g
25.0	1200	0.310g	0.281g	–	–	1500	0.239g
27.5	1200	0.302g	0.252g	–	–	1500	0.241g
30.0	1200/1600	0.219g	0.268g	0.463g	-	1500/1600	0.275g
35.0	1600	0.223g	0.286g	0.361g	-	1600	0.300g
40.0	1600/2000	0.229g	0.185g	0.359g	0.393g	1600/2000	0.224g
45.0	2000	0.223g	0.180g	0.335g	0.353g	2000	0.232g
50.0	2000	0.180g	0.164g	0.301g	0.250g	2000	0.193g
55.0	2000/3300	0.181g	0.162g	0.212g	0.213g	2000/3300	0.174g
60.0	3300	0.175g	0.158g	0.184g	0.227g	3300	0.169g
65.0	3300	0.157g	0.159g	0.171g	0.229g	3300	0.171g
70.0	3300	0.151g	0.158g	0.151g	0.214g	3300	0.163g
Outcrop	6300	0.213g	0.213g	0.213g	0.213g	6300	0.213g
			High Frequency Case				
0.0	700	0.906g	0.989g	–[a.]	-	1275	0.918g
2.5	700	0.792g	0.860g	-	-	1275	0.872g
5.0	700	0.612g	0.752g	-	-	1275	0.748g
7.5	700	0.654g	0.669g	-	-	1275	0.698g
10.0	700/950	0.703g	0.810g	-	-	1275/1380	0.605g

Table 2.5-46 ZPA Results from SHAKE Analysis

		Profile 1					
Depth, ft	**V_s, ft/sec**	**G_{max}**	**150% G_{max}**	**Profile 2**	**Profile 3**	**V_s, ft/sec**	**Profile 4**
			High Frequency Case (continued)				
12.5	950	0.698g	0.762g	-	-	1380	0.474g
15.0	950	0.632g	0.776g	-	-	1380	0.486g
17.5	950	0.627g	0.753g	-	-	1380	0.557g
20.0	950/1200	0.558g	0.744g	-	-	1380/1500	0.619g
22.5	1200	0.511g	0.834g	-	-	1500	0.648g
25.0	1200	0.590g	0.826g	-	-	1500	0.695g
27.5	1200	0.658g	0.722g	-	-	1500	0.726g
30.0	1200/1600	0.630g	0.607g	1.034g	-	1500/1600	0.667g
35.0	1600	0.674g	0.532g	0.902g	-	1600	0.746g
40.0	1600/2000	0.652g	0.535g	0.680g	0.989g	1600/2000	0.506g
45.0	2000	0.535g	0.493g	0.572g	0.853g	2000	0.428g
50.0	2000	0.425g	0.416g	0.498g	0.542g	2000	0.389g
55.0	2000/3300	0.321g	0.435g	0.411g	0.414g	2000/3300	0.346g
60.0	3300	0.312g	0.423g	0.400g	0.371g	3300	0.336g
65.0	3300	0.291g	0.384g	0.378g	0.358g	3300	0.303g
70.0	3300	0.286g	0.366g	0.451g	0.339g	3300	0.343g
Outcrop	6300	0.431g	0.431g	0.431g	0.431g	6300	0.431g

a. Dash denotes soil not present.

Soil/Rock Columns

1. Profile from 0 to 70 feet, with 30 feet of unimproved Zone IIA saprolite, 10 feet of Zone IIB saprolite, 15 feet of Zone III rock, and 15 feet of Zone III-IV rock.
2. Profile from 30 to 70 feet depth for foundation sitting on 10 feet of Zone IIB saprolite, 15 feet of Zone III weathered rock, and 15 feet of Zone III-IV rock.
3. Profile from 40 to 70 feet depth for foundation sitting on 15 feet of Zone III weathered rock and 15 feet of Zone III-IV rock.
4. Profile from 0 to 70 feet, with 30 feet of improved Zone IIA saprolite, 10 feet of Zone IIB saprolite, 55 feet of Zone III weathered rock, and 15 feet of Zone III-IV rock.

Table 2.5-47 Allowable Bearing Capacity Values

Zone	Allowable Bearing Capacity, ksf
IIB	8
III	16
III-IV	80[a]
IV	160[a]

Note: The above values include a factor of safety against bearing failure of at least 3.
Minimum assumed foundation width is 5 feet. Minimum assumed foundation depth is 3 feet.

a. The new containment (reactor) buildings would be founded on Zone III-IV or Zone IV material.

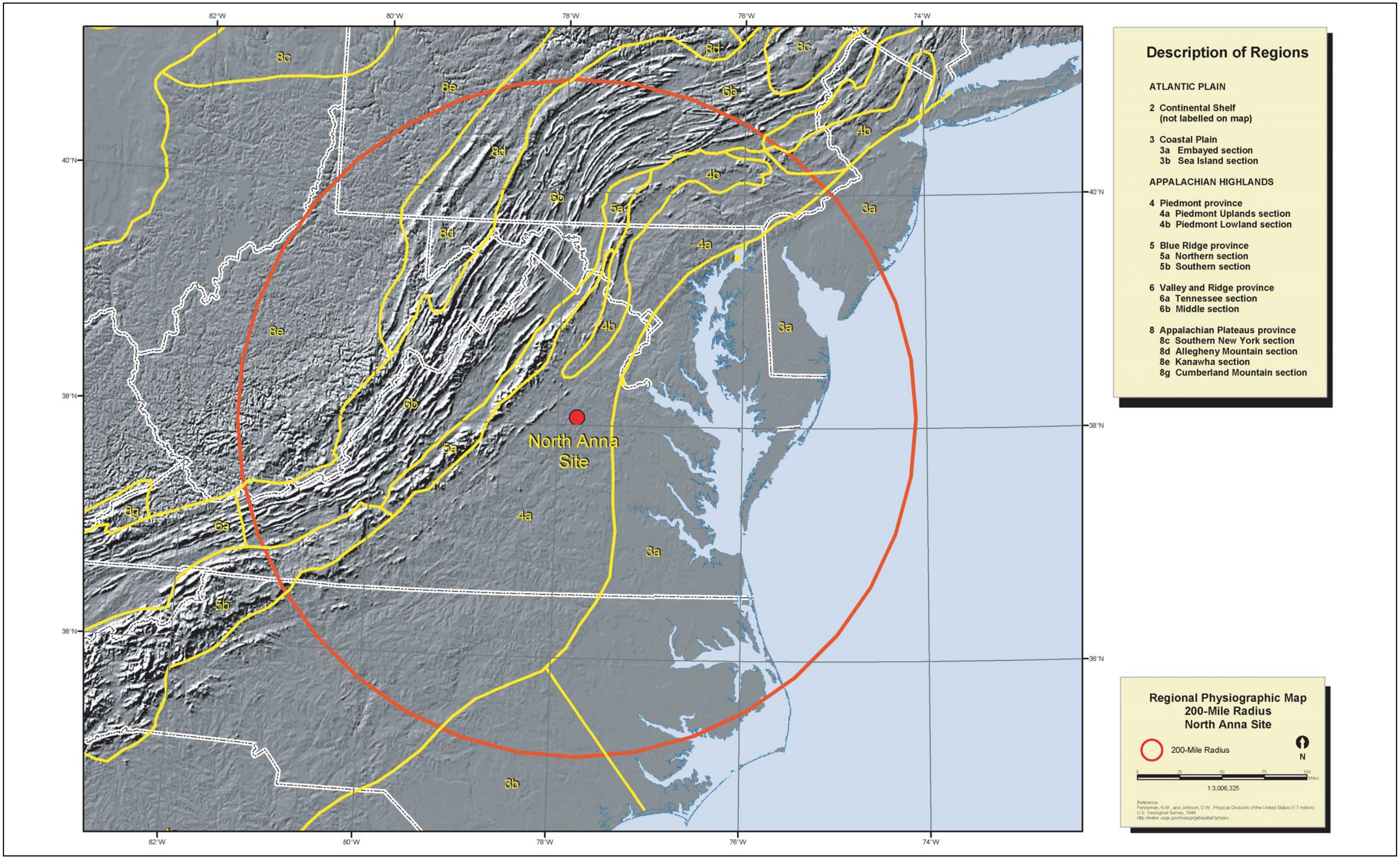
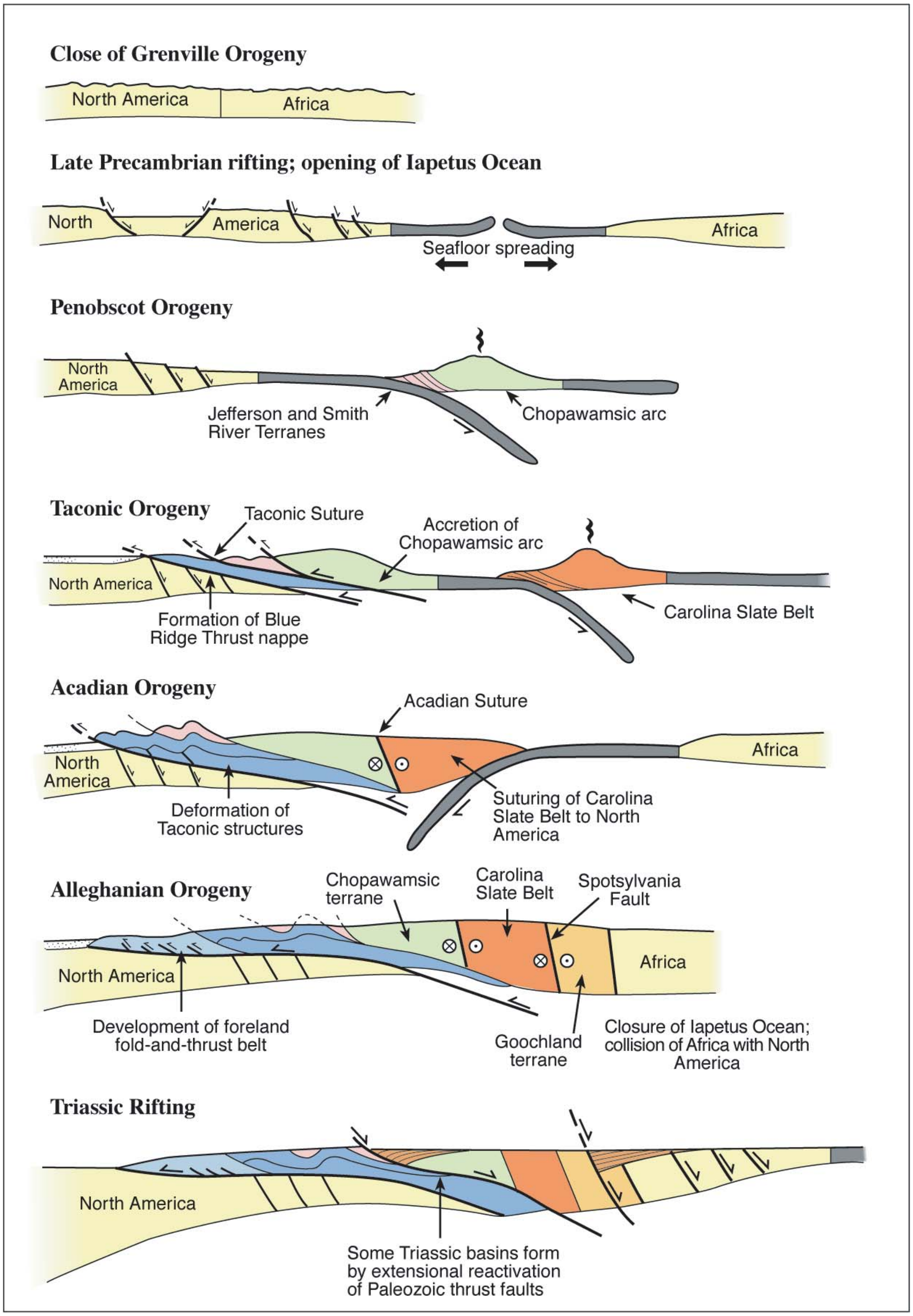


Figure 2.5-1 Regional Physiographic Map (200-Mile Radius)



Modified from Hatcher, 1987

Figure 2.5-2 Evolution of the Appalachian Orogen (after Hatcher, 1987)

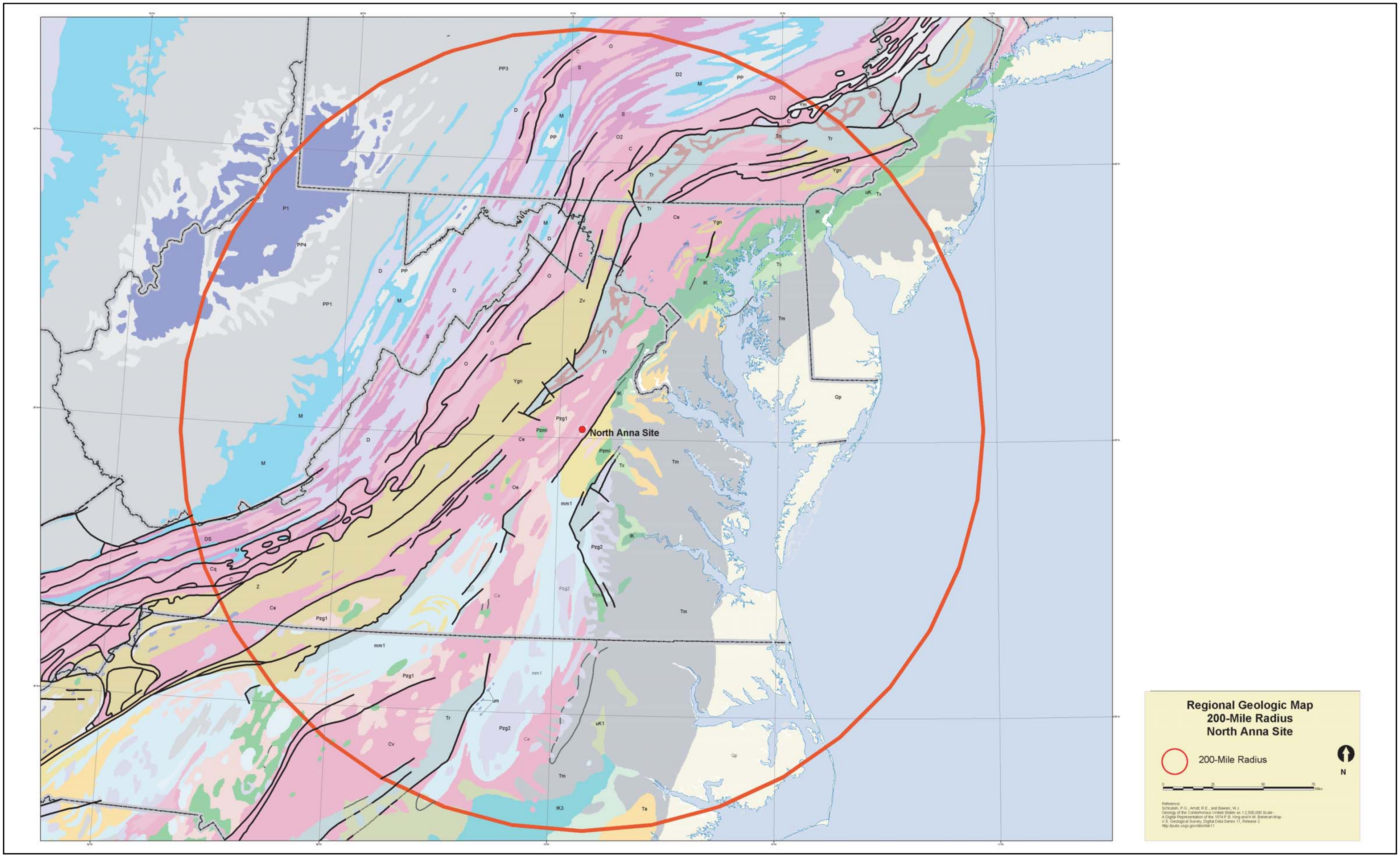


Figure 2.5-3 Regional Geologic Map (200-Mile Radius) (Sheet 1 of 2)

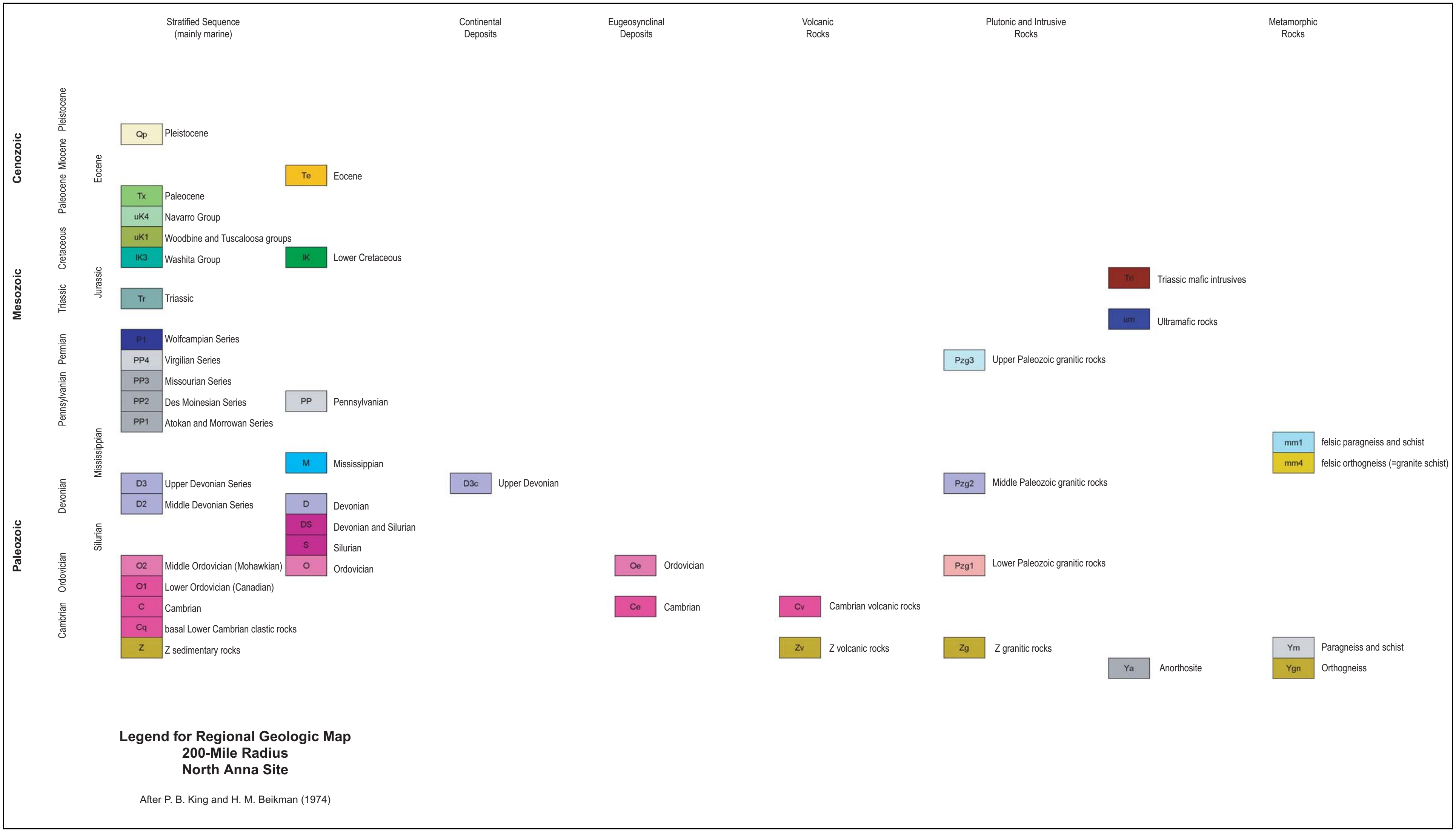


Figure 2.5-3 Regional Geologic Map (200-Mile Radius) (Sheet 2 of 2)

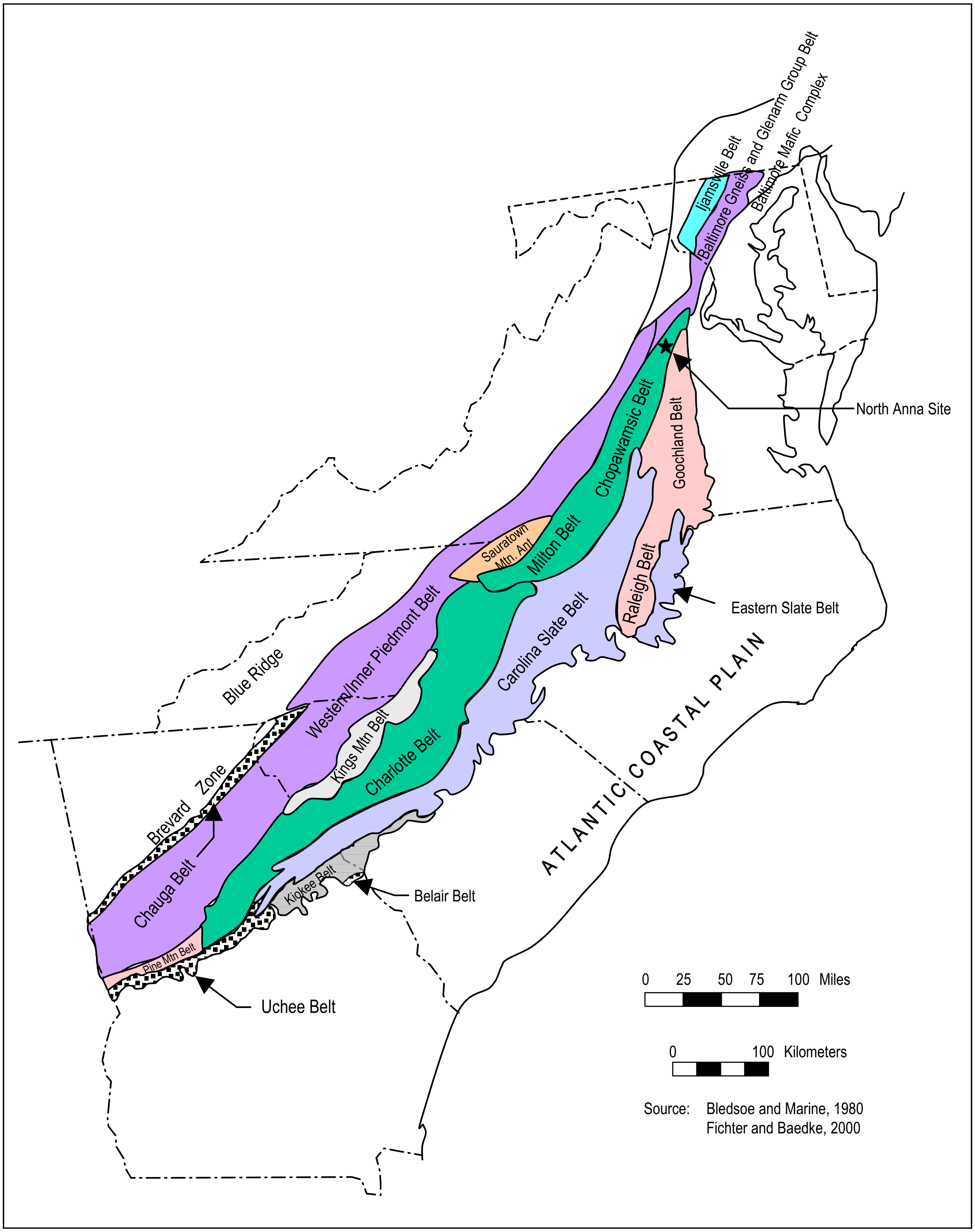


Figure 2.5-4 Lithotectonic Belts of the Piedmont Province

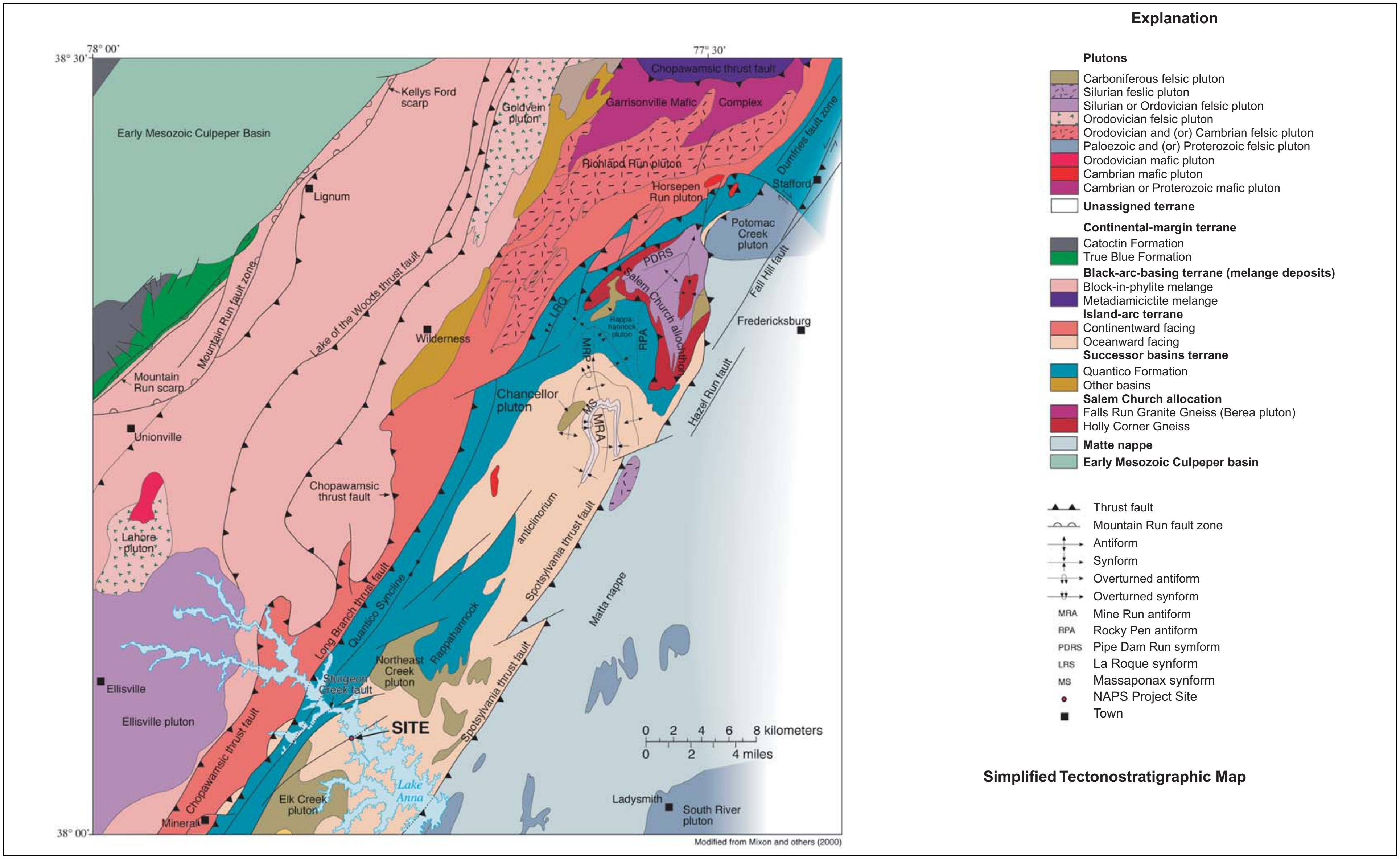


Figure 2.5-5 Simplified Tectonostratigraphic Map

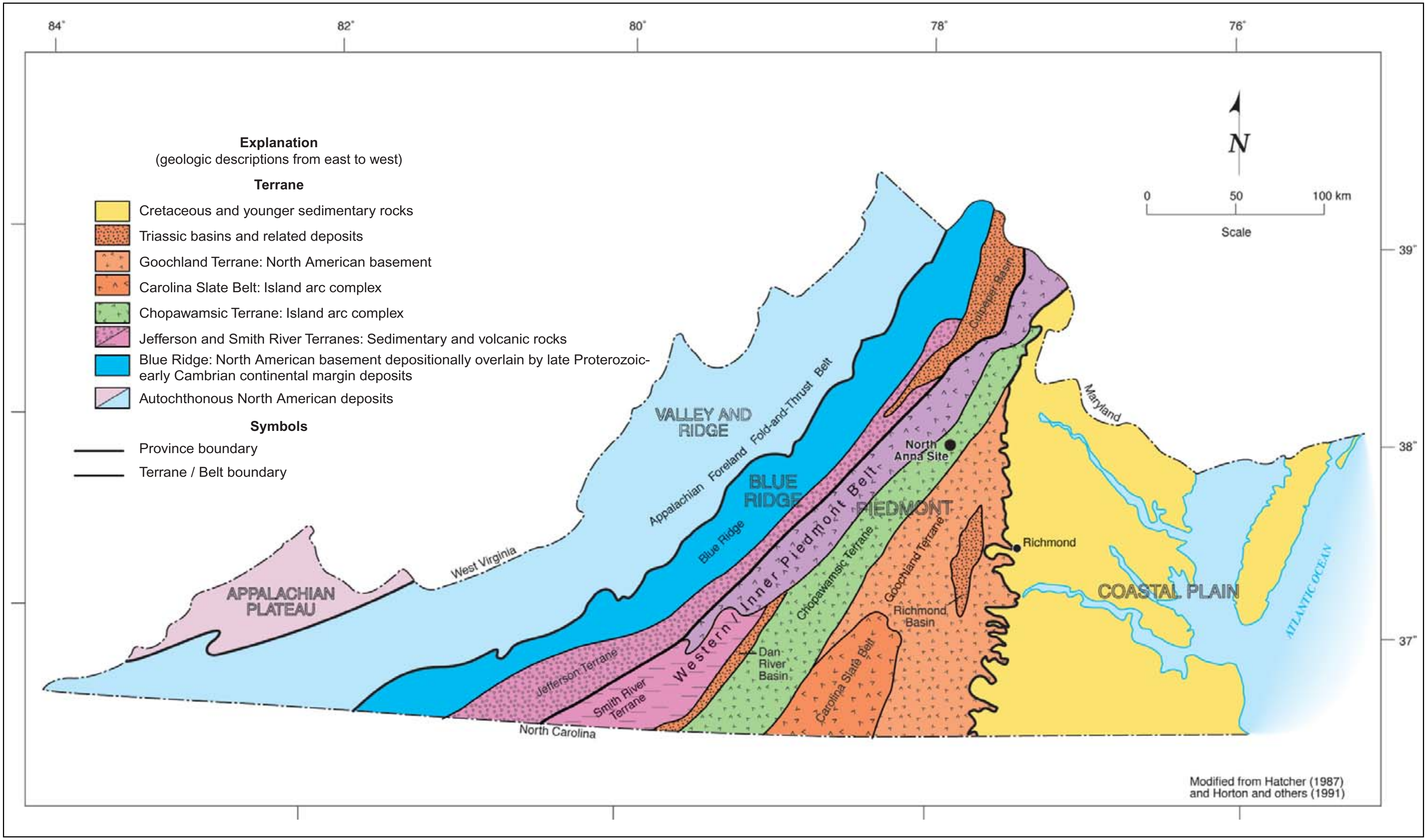


Figure 2.5-6 Simplified Tectonic Map of Virginia

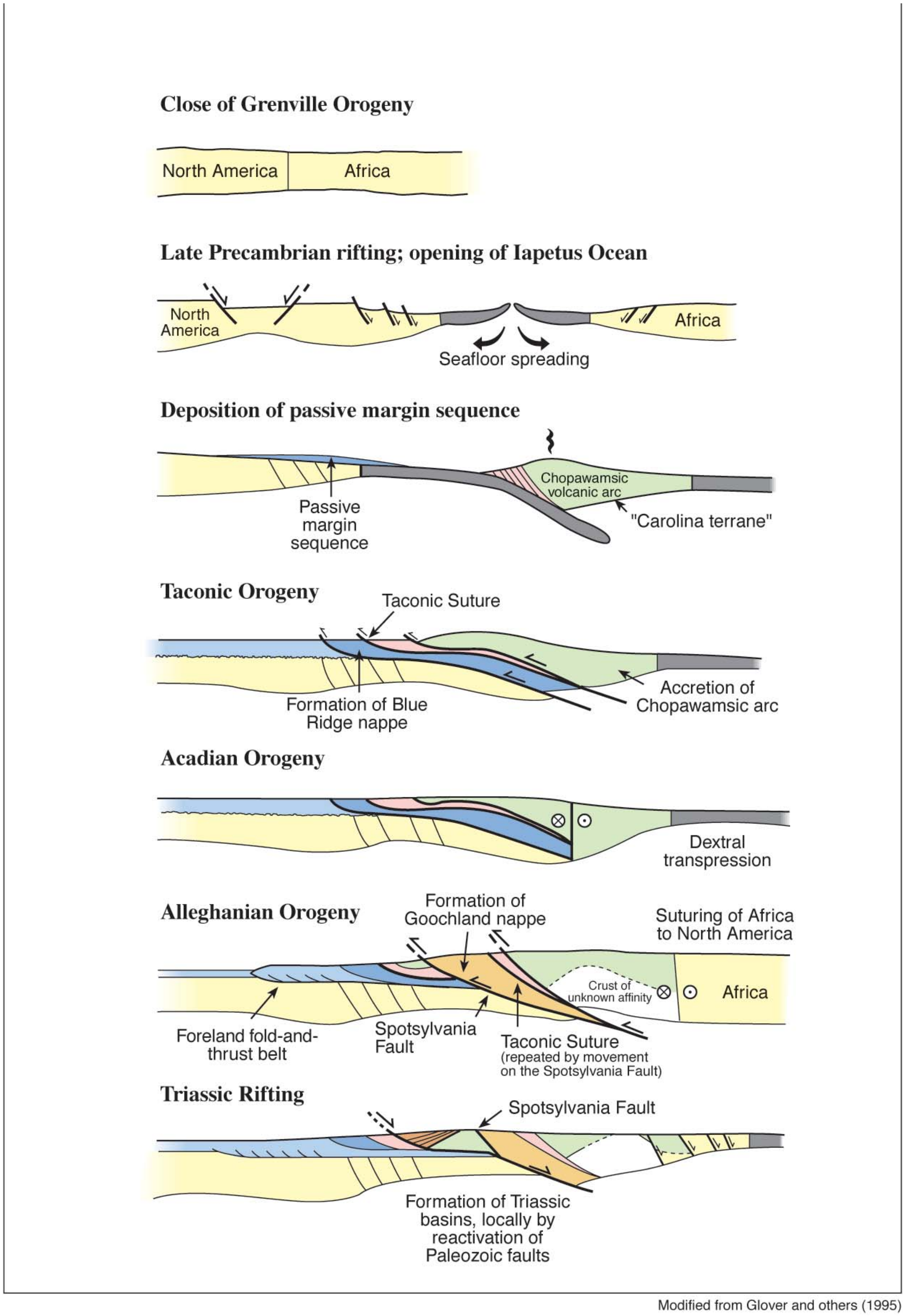


Figure 2.5-7 Evolution of the Appalachian Orogen (after Glover and others, 1995)

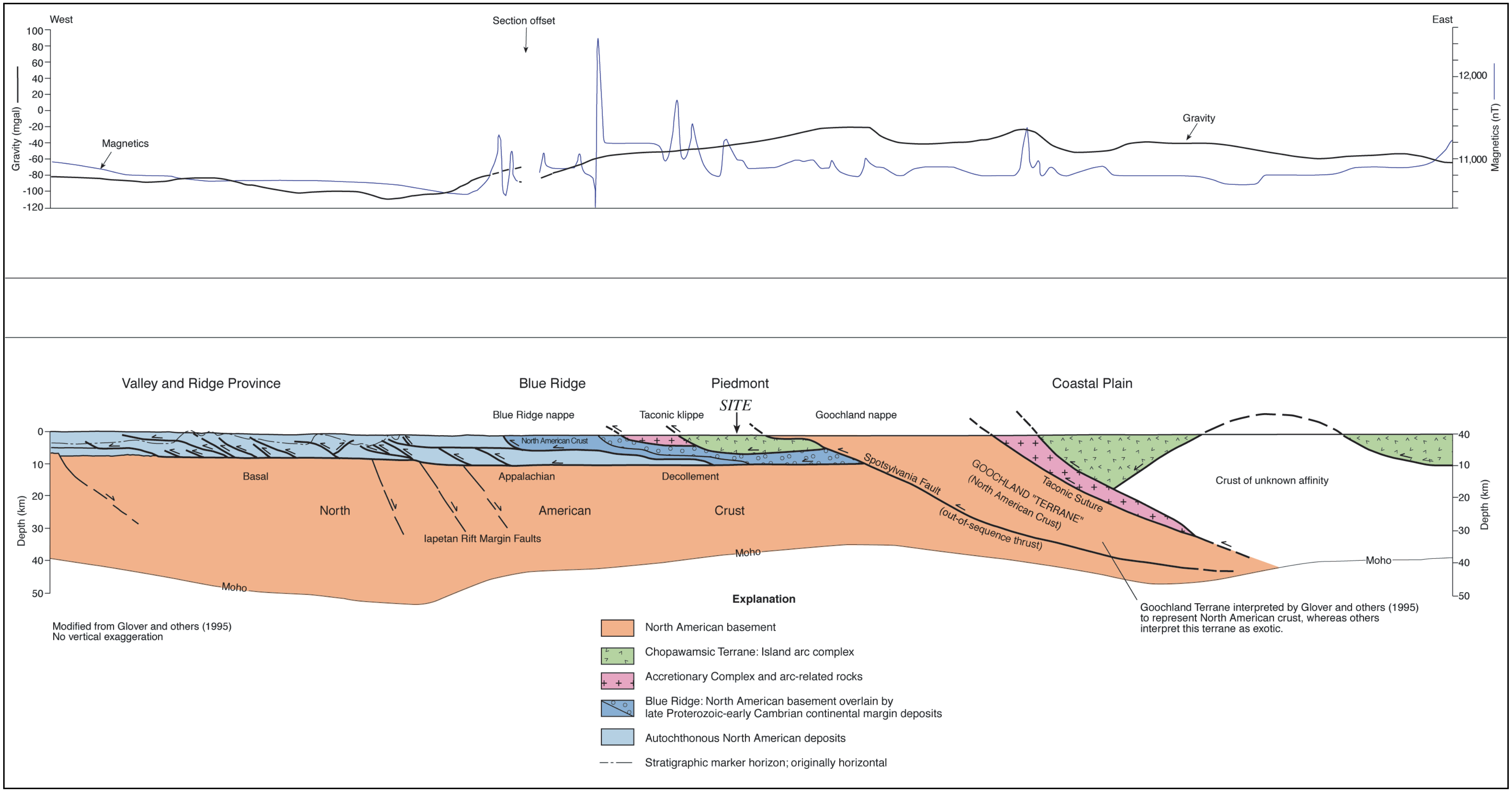


Figure 2.5-8 Crustal Section Through Appalachian Orogen (200-mile radius)

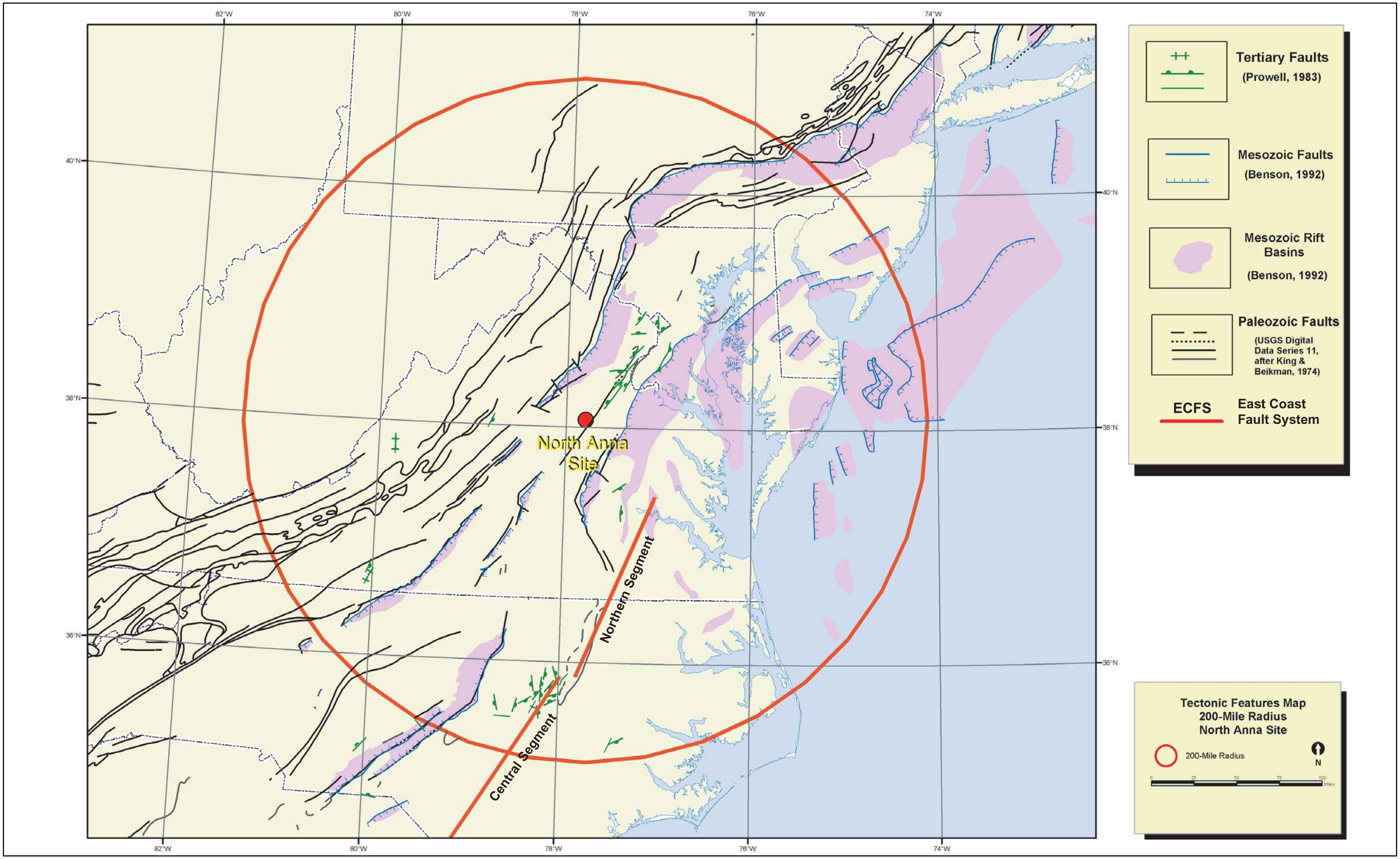


Figure 2.5-9 Tectonic Features Map (200-mile radius)

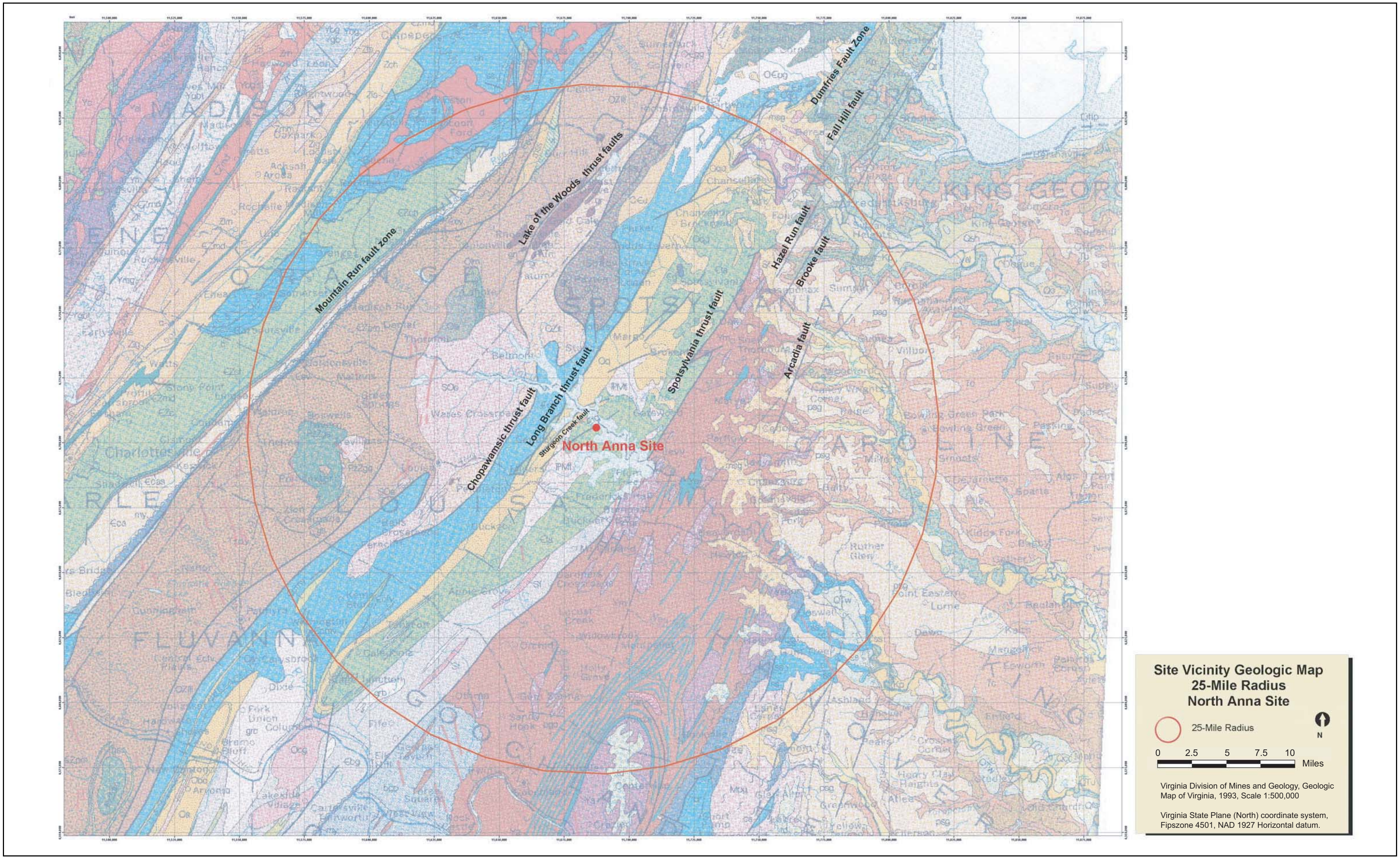


Figure 2.5-10 Site Vicinity Geologic Map (25-Mile Radius) (Sheet 1 of 2)

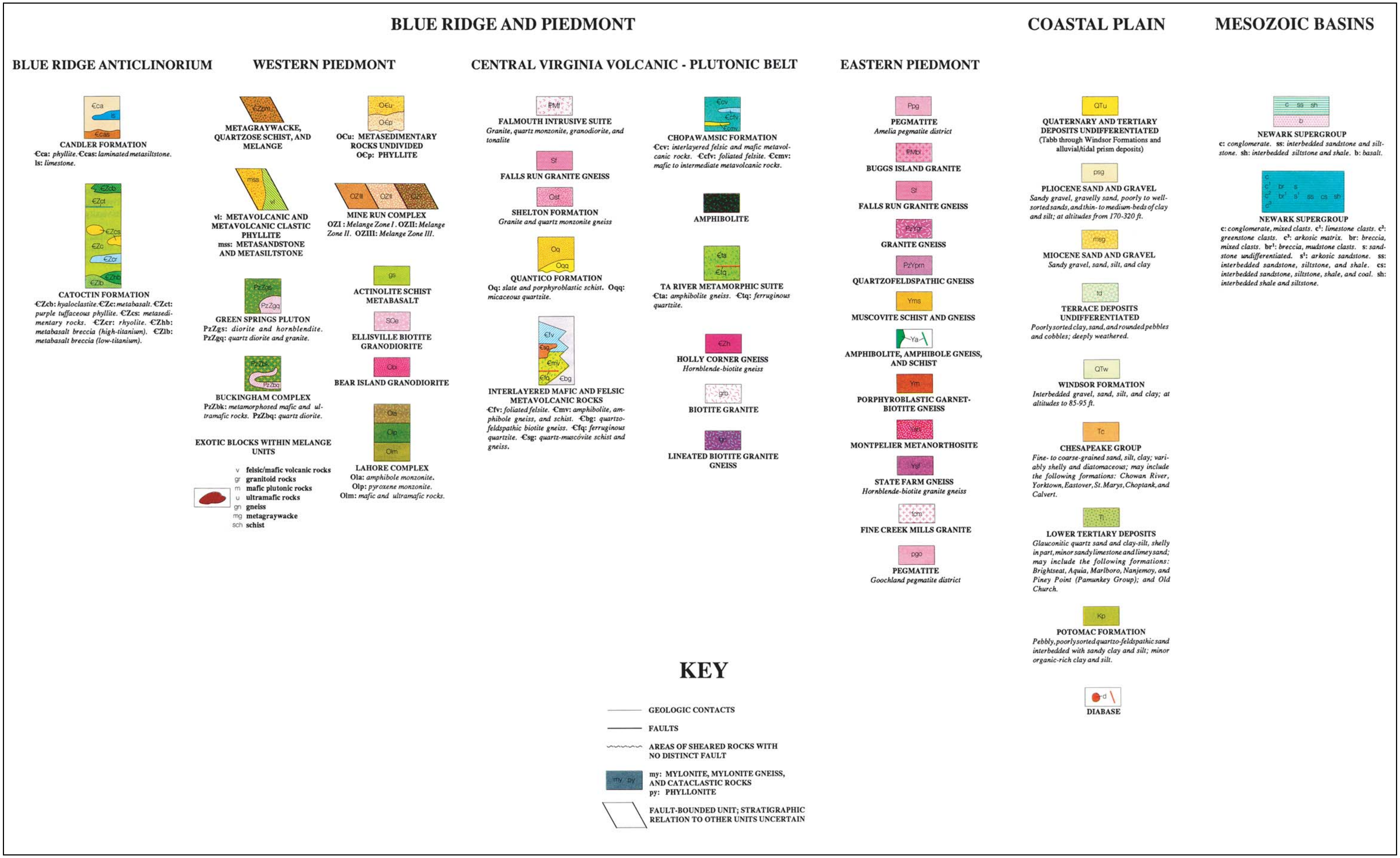


Figure 2.5-10 Site Vicinity Geologic Map (25-Mile Radius) (Sheet 2 of 2)

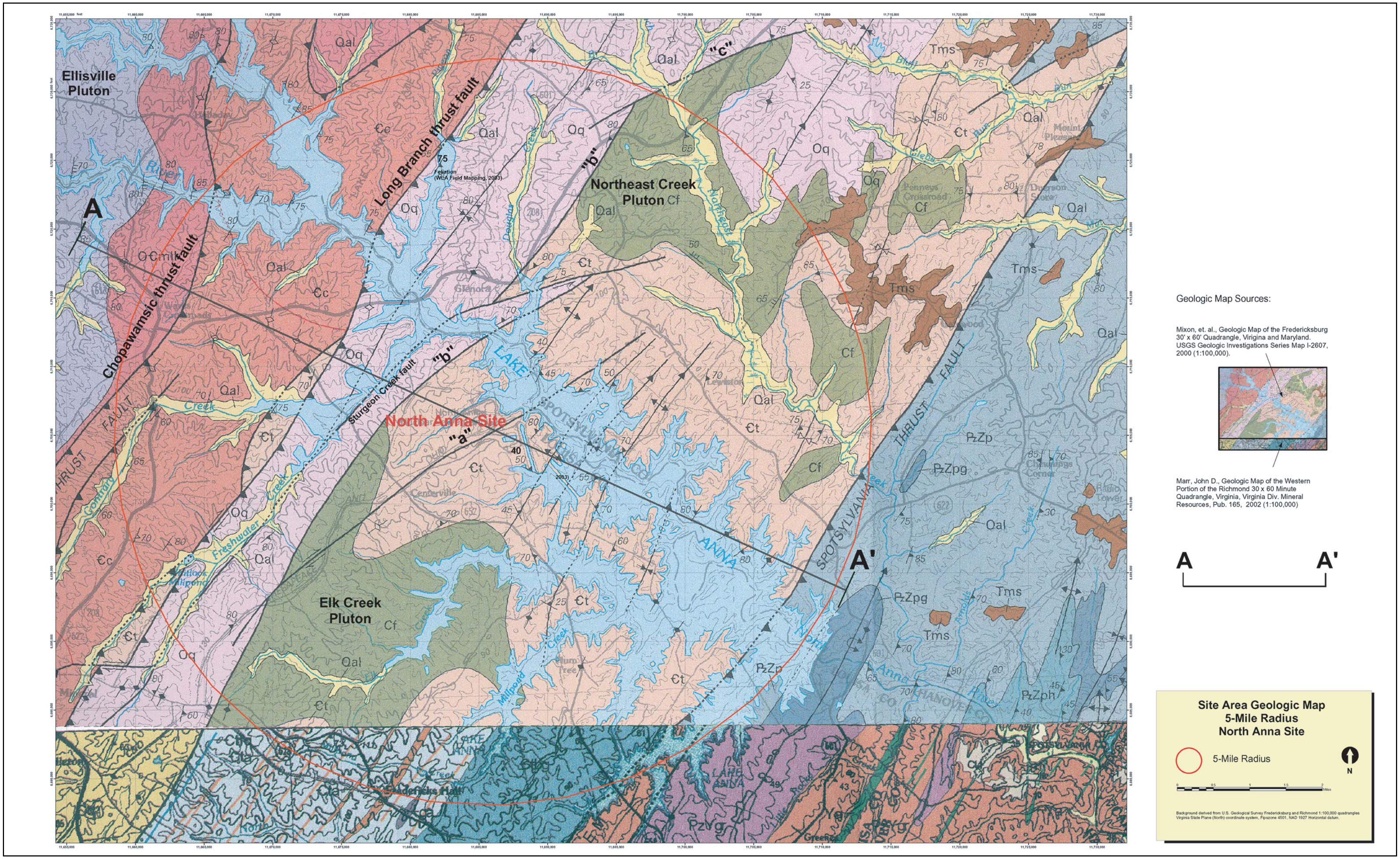


Figure 2.5-11 Site Area Geologic Map (5-Mile Radius) (Sheet 1 of 2)

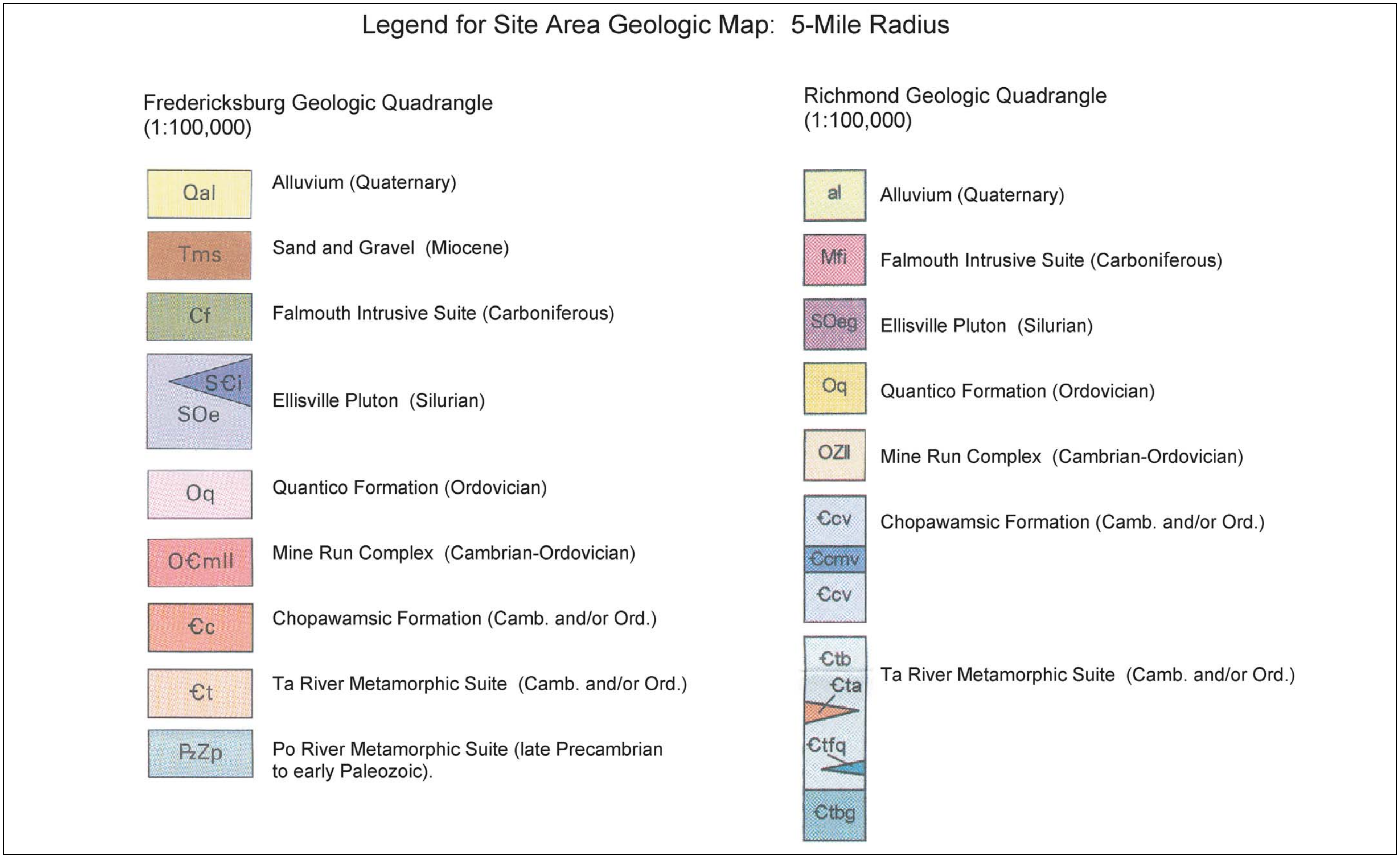


Figure 2.5-11 Site Area Geologic Map (5-Mile Radius) (Sheet 2 of 2)

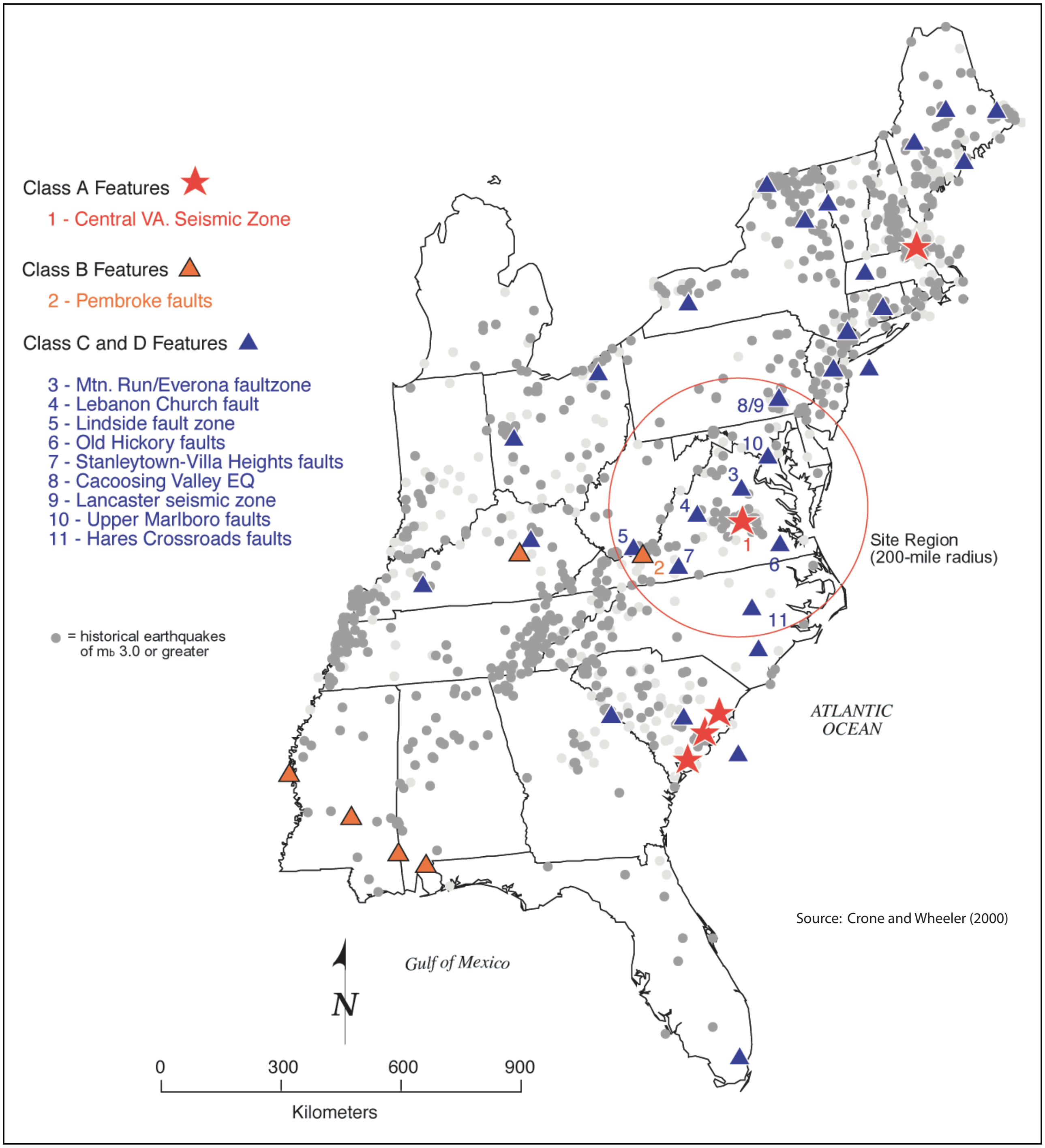


Figure 2.5-12 Quaternary Features Map

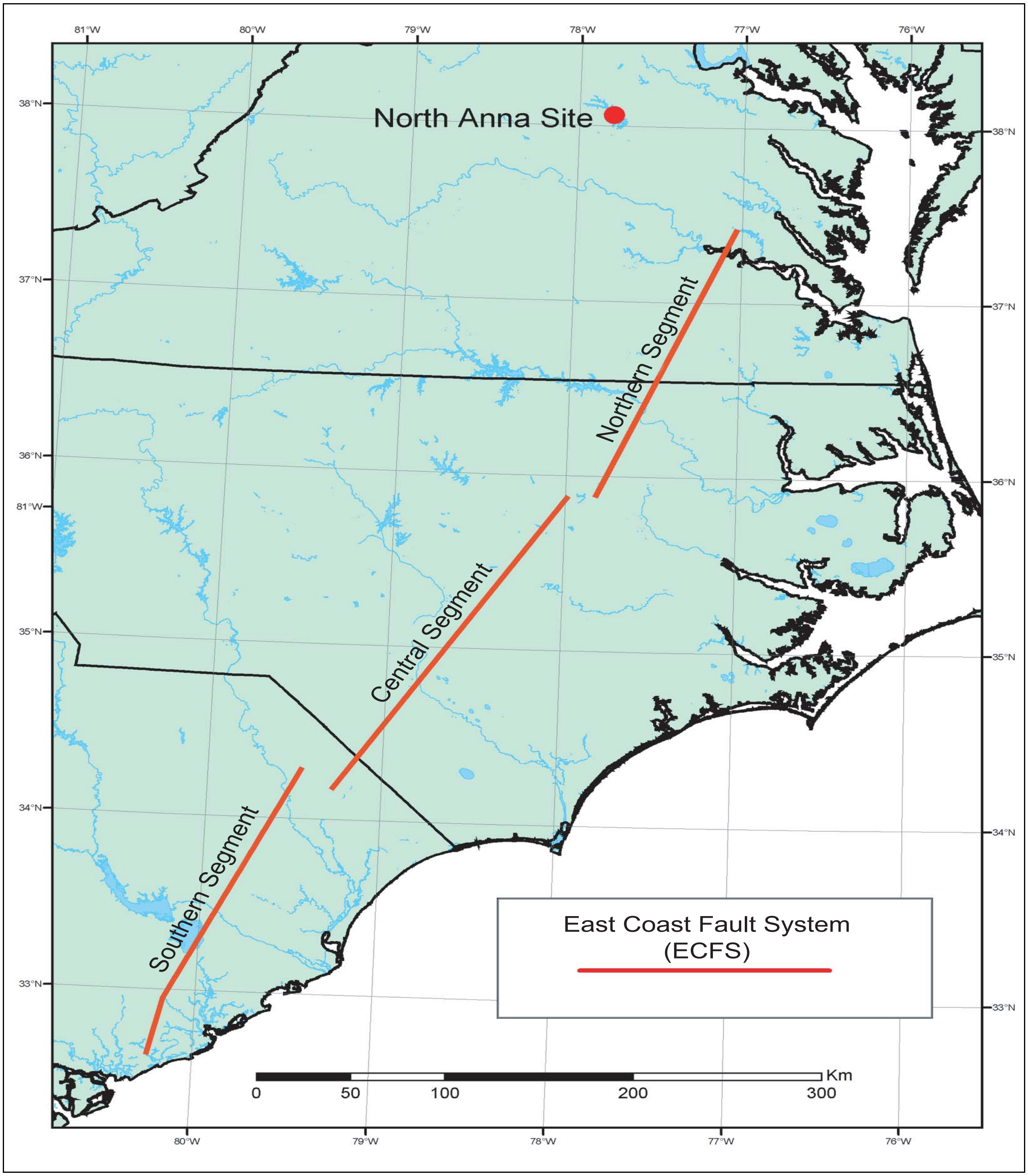


Figure 2.5-13 Northern, Central, and Southern Segments of the East Coast Fault System

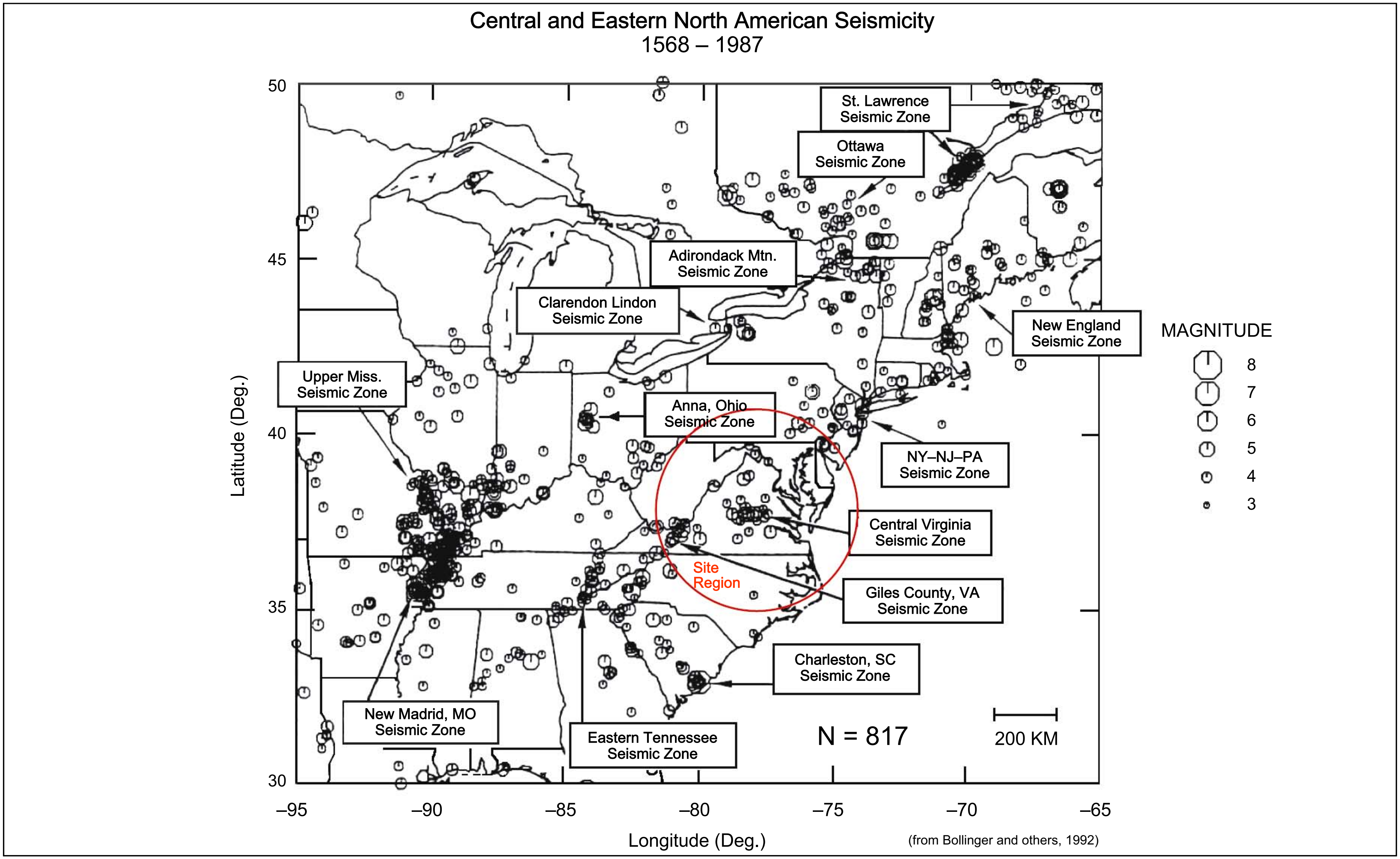


Figure 2.5-14 Seismic Source Zones and Seismicity in Central and Eastern North America

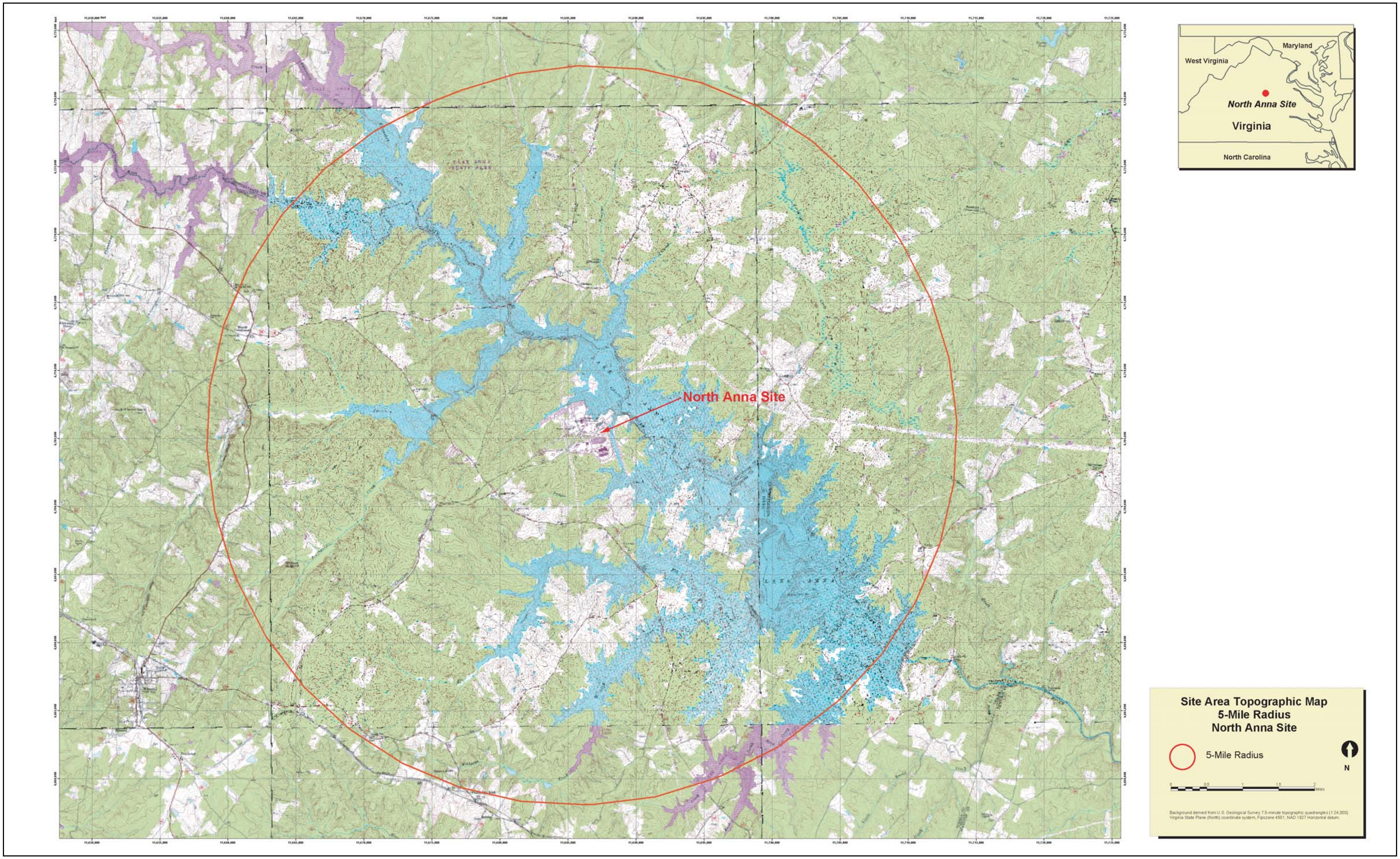


Figure 2.5-15 Site Area Topographic Map (5-Mile Radius)

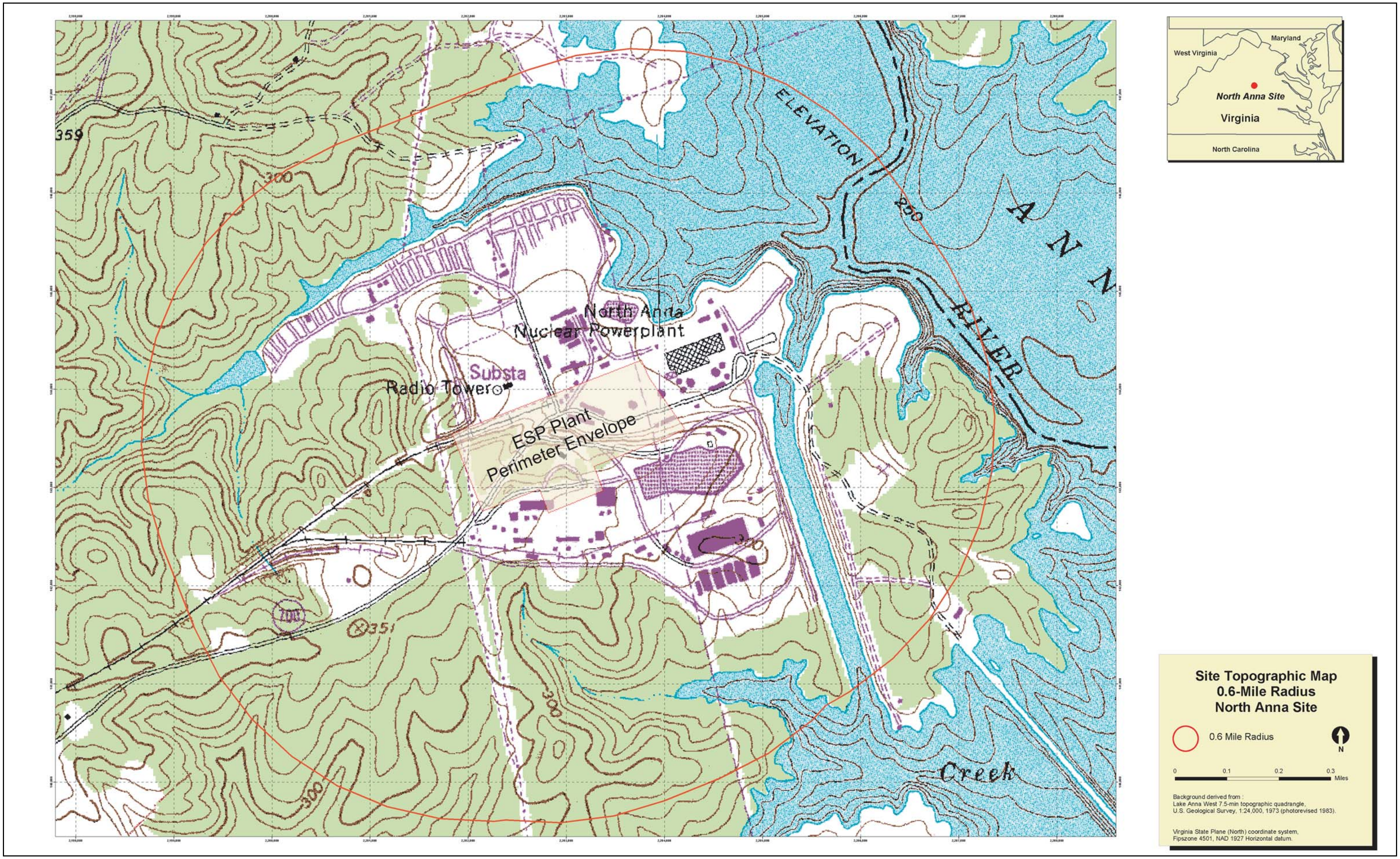
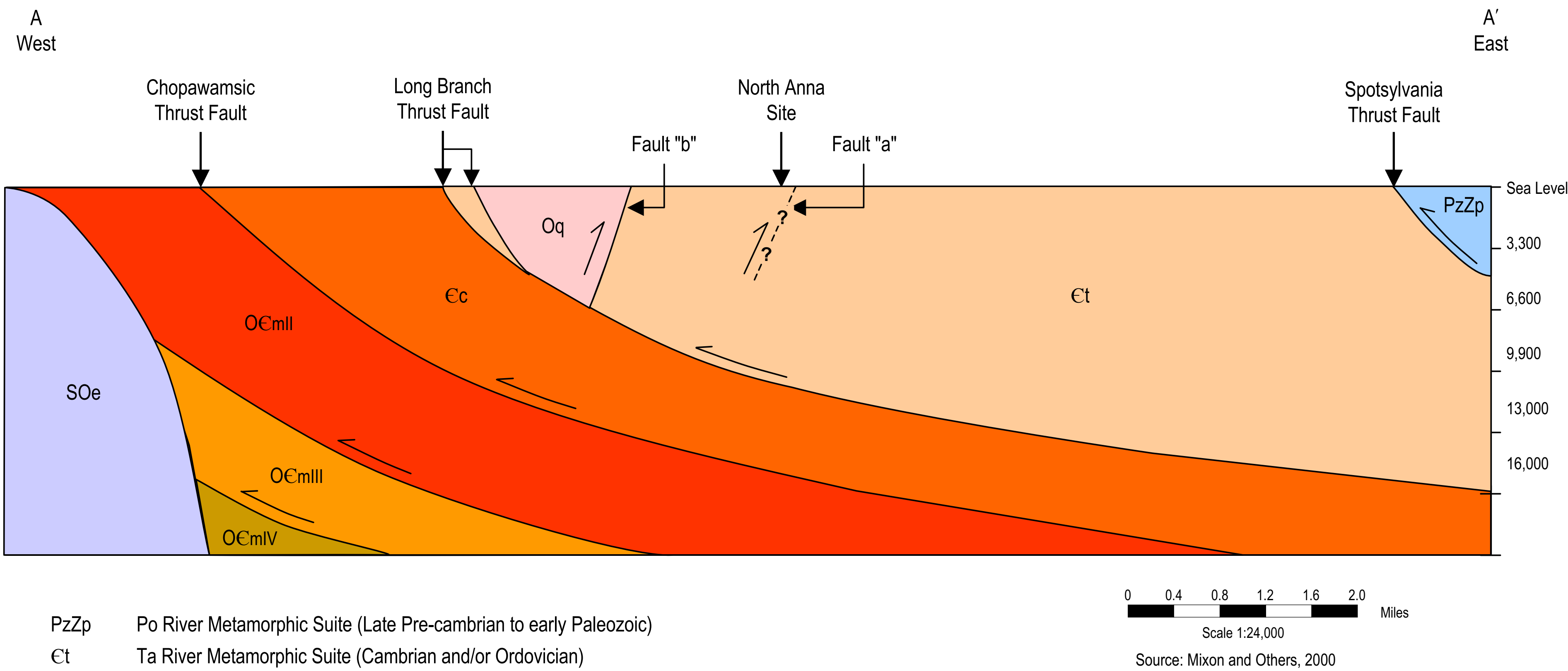


Figure 2.5-16 Site Topographic Map (0.6-Mile Radius)



PzZp	Po River Metamorphic Suite (Late Pre-cambrian to early Paleozoic)
Єt	Ta River Metamorphic Suite (Cambrian and/or Ordovician)
Єc	Chopawamsic Formation (Cambrian and/or Ordovician)
OЄmII	Melange Zone II (Cambrian and/or Ordovician)
OЄmIII	Melange Zone III (Cambrian and/or Ordovician)
OЄmIV	Melange Zone IV (Cambrian and/or Ordovician)
Oq	Quantico Formation (Ordovician)
SOe	Ellisville Pluton (Silurian)

Figure 2.5-17 Site Area Geologic Cross Section A-A' (5-Mile Radius)

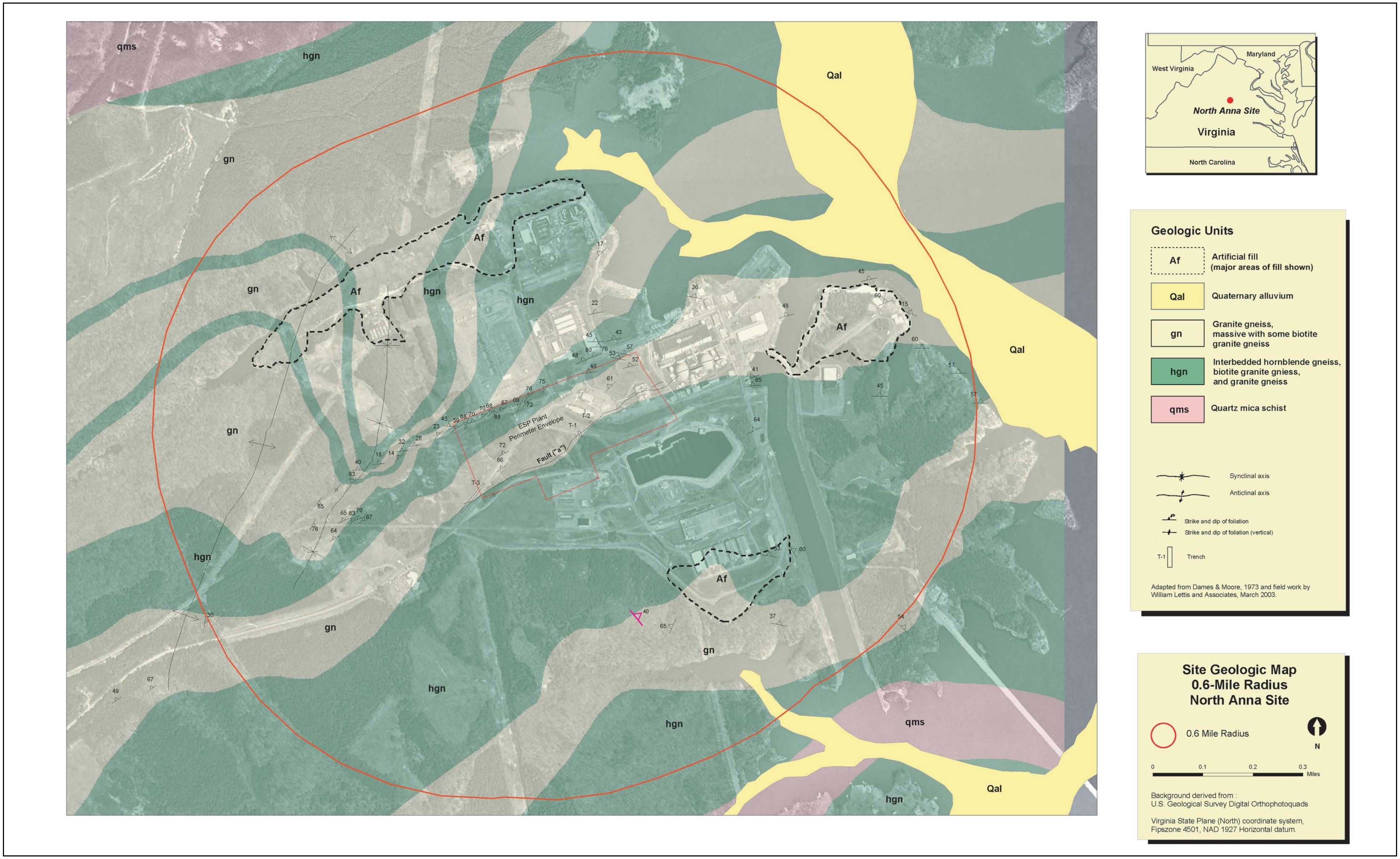


Figure 2.5-18 Site Geologic Map (0.6-Mile Radius)

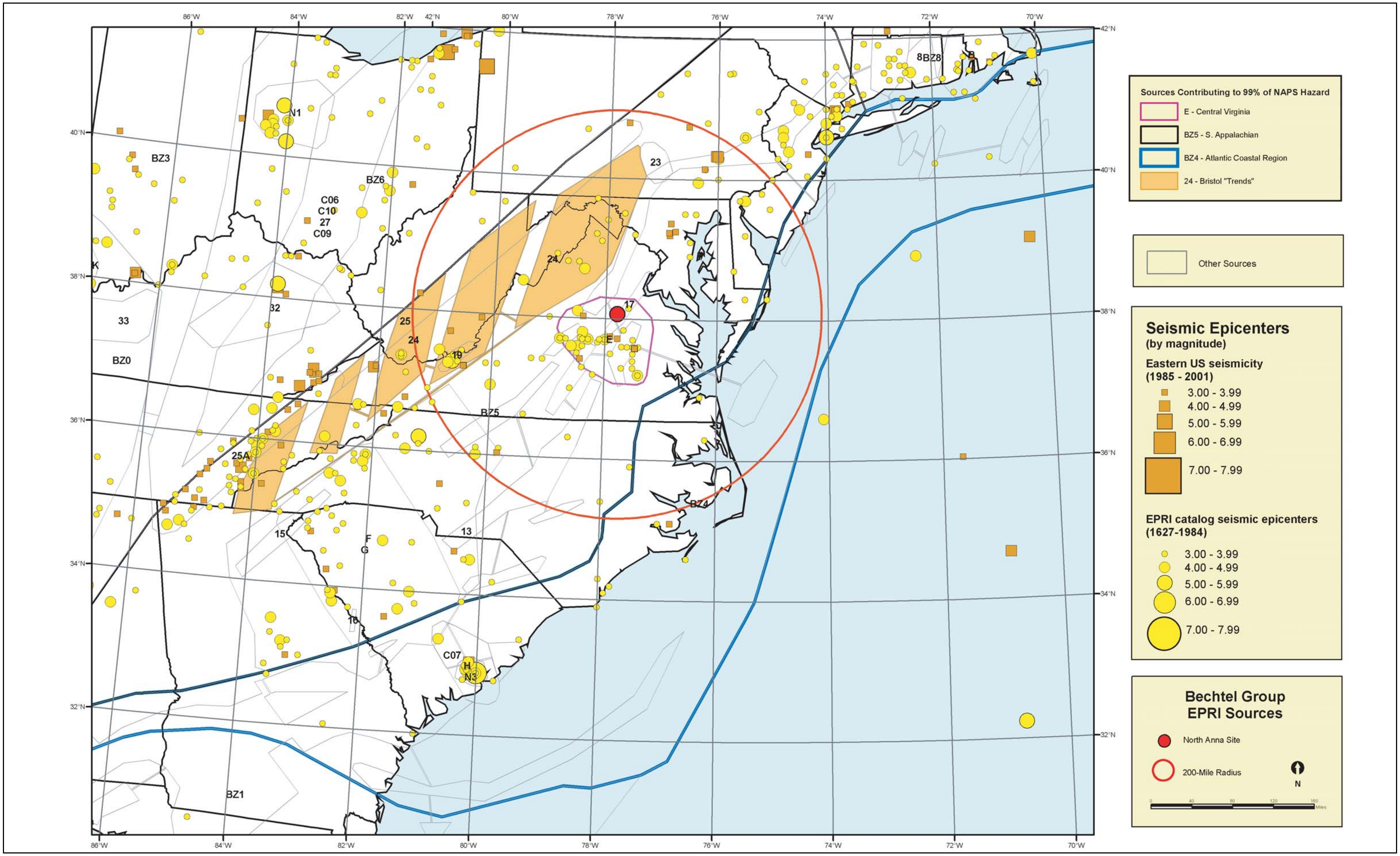


Figure 2.5-19 Bechtel Group EPRI Sources

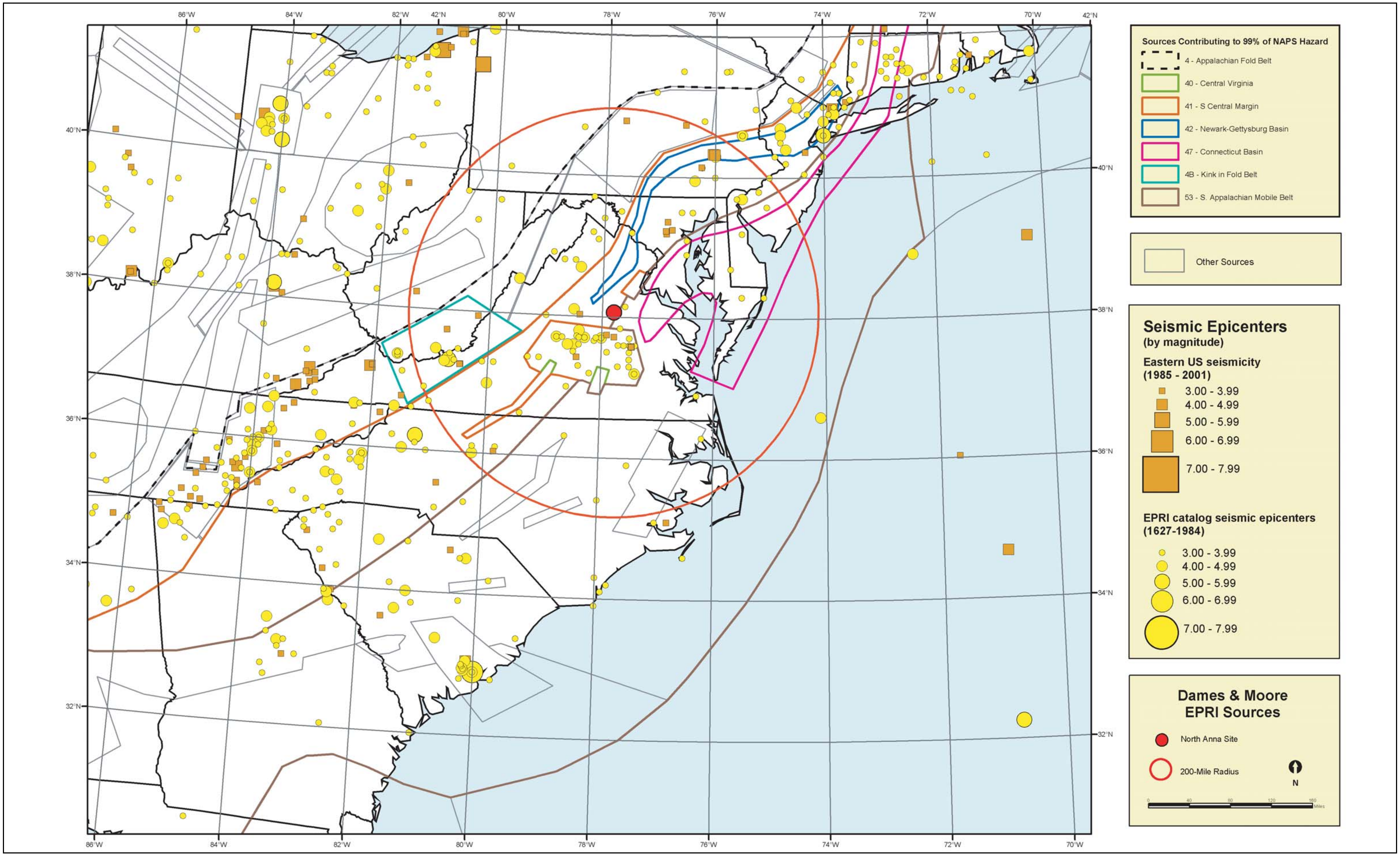


Figure 2.5-20 Dames & Moore EPRI Sources

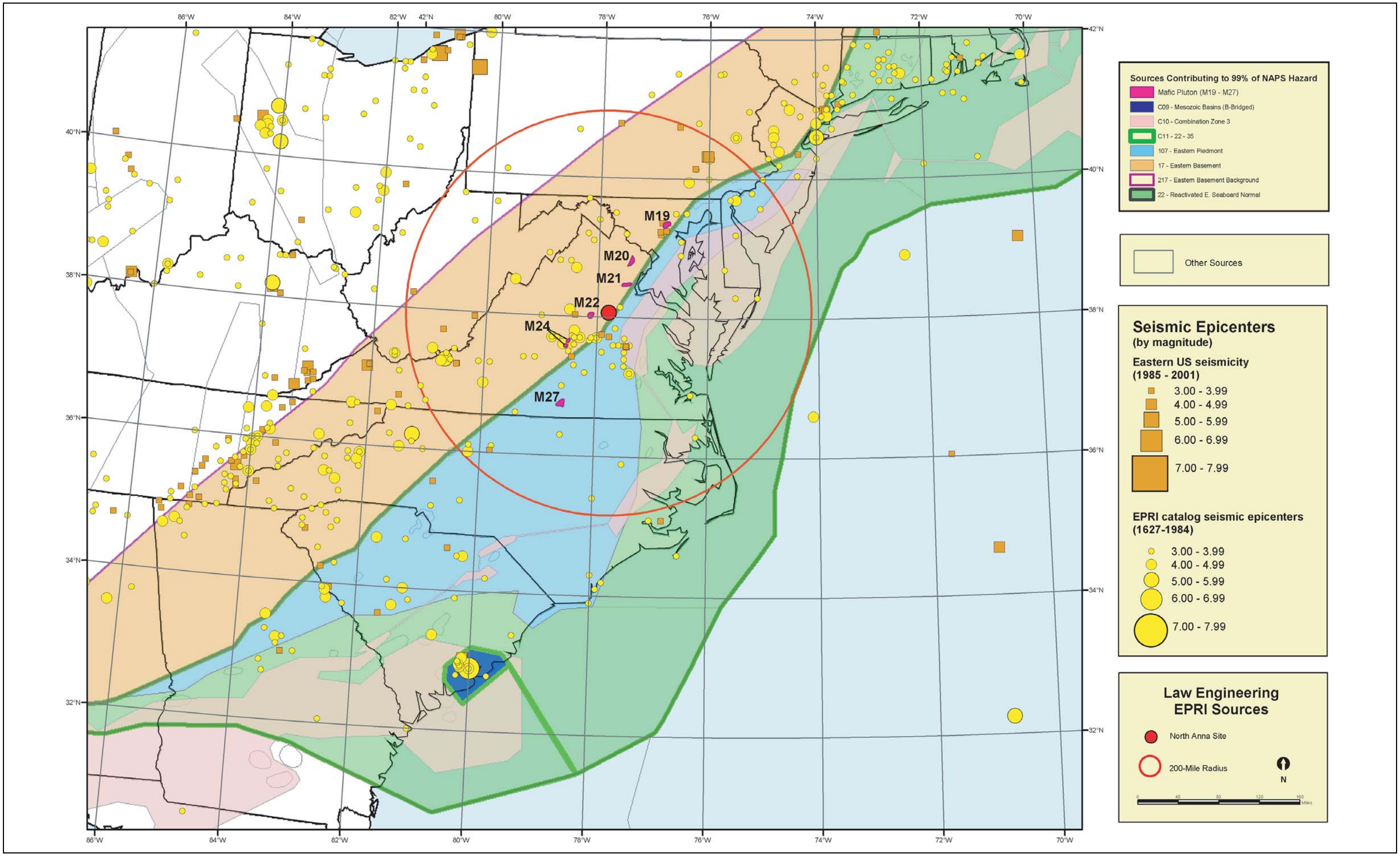


Figure 2.5-21 Law Engineering EPRI Sources

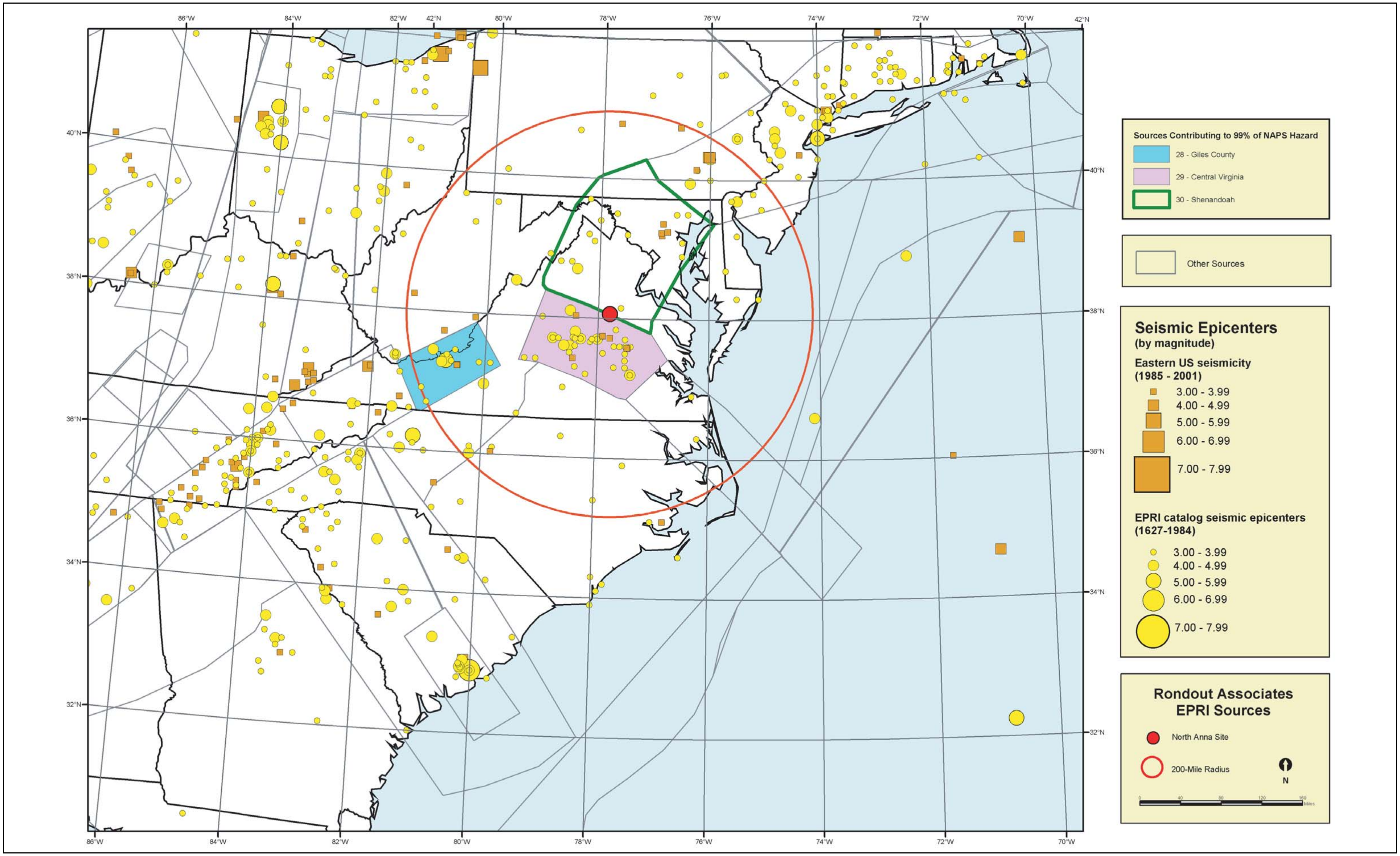


Figure 2.5-22 Rondout Associates EPRI Sources

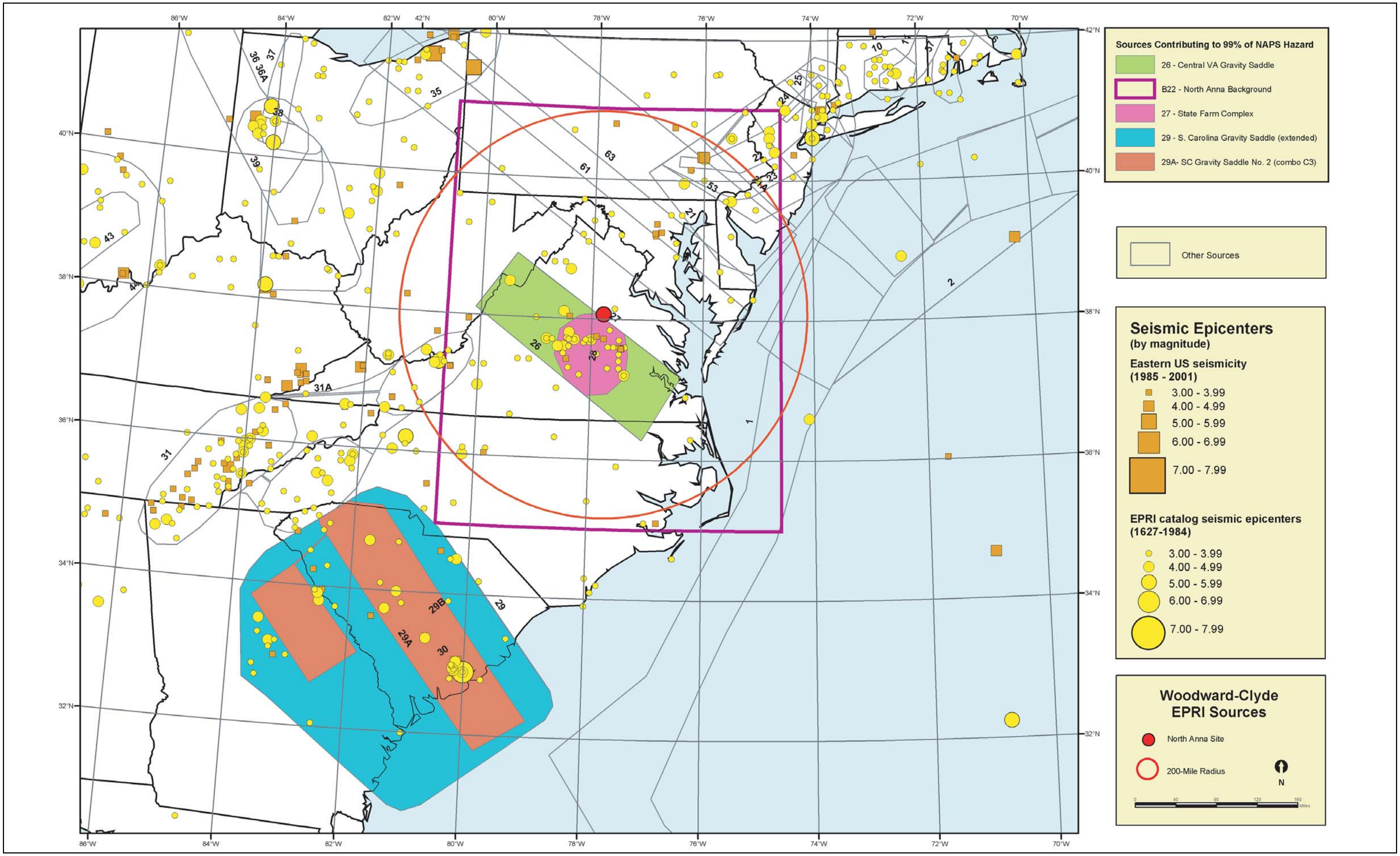


Figure 2.5-23 Woodward-Clyde EPRI Sources

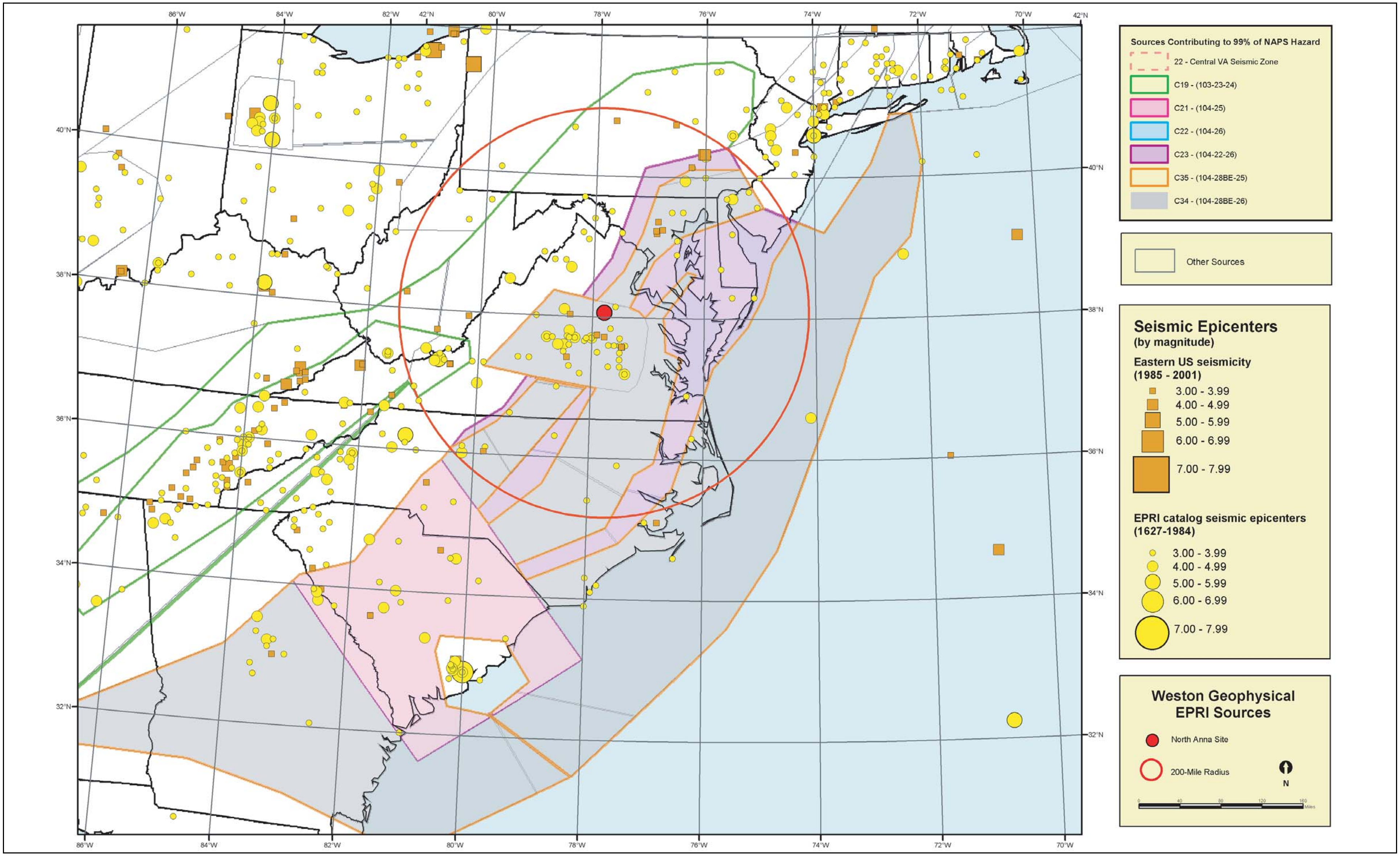


Figure 2.5-24 Weston EPRI Sources

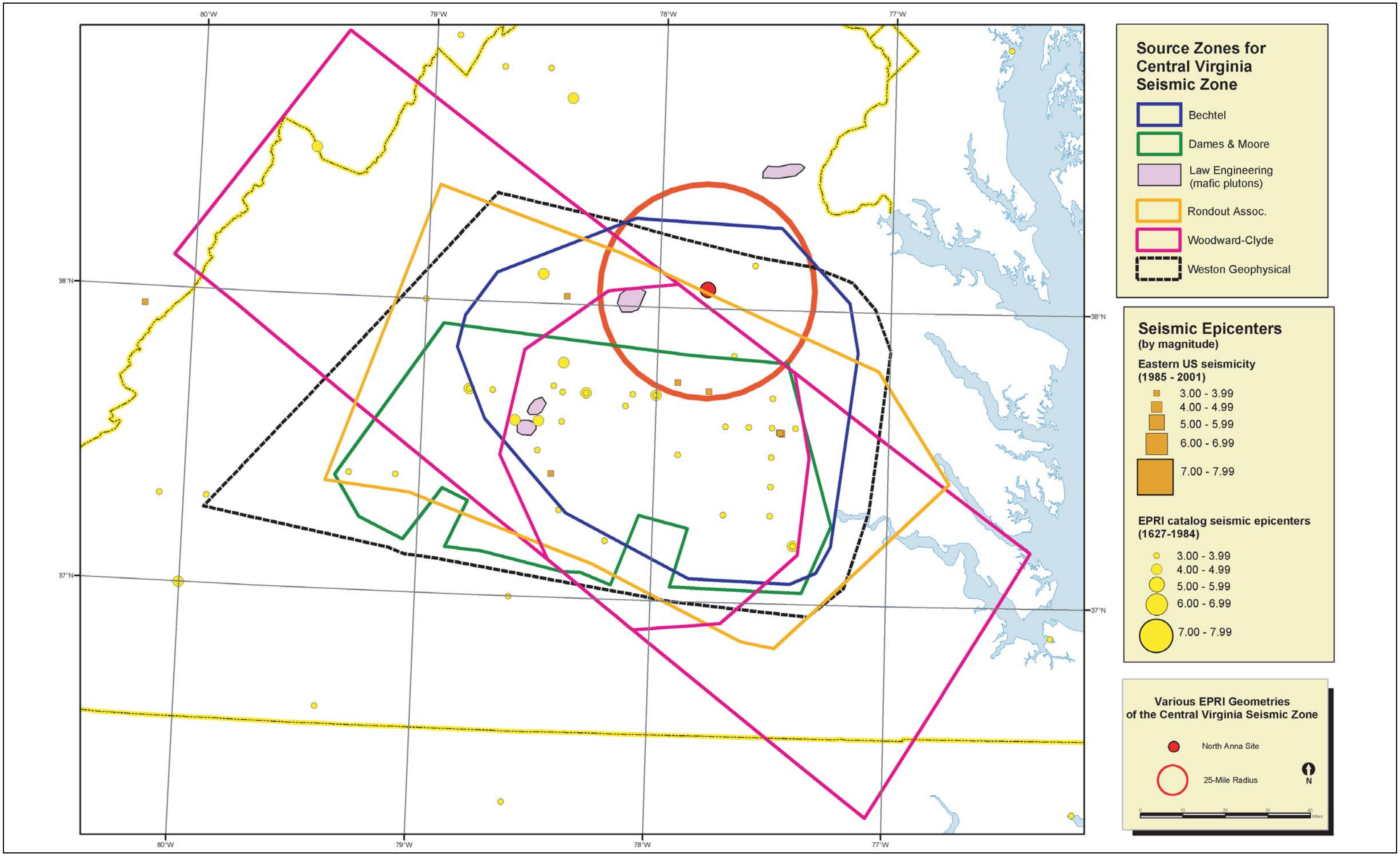


Figure 2.5-25 Various EPRI Geometries of the Central Virginia Seismic Zone

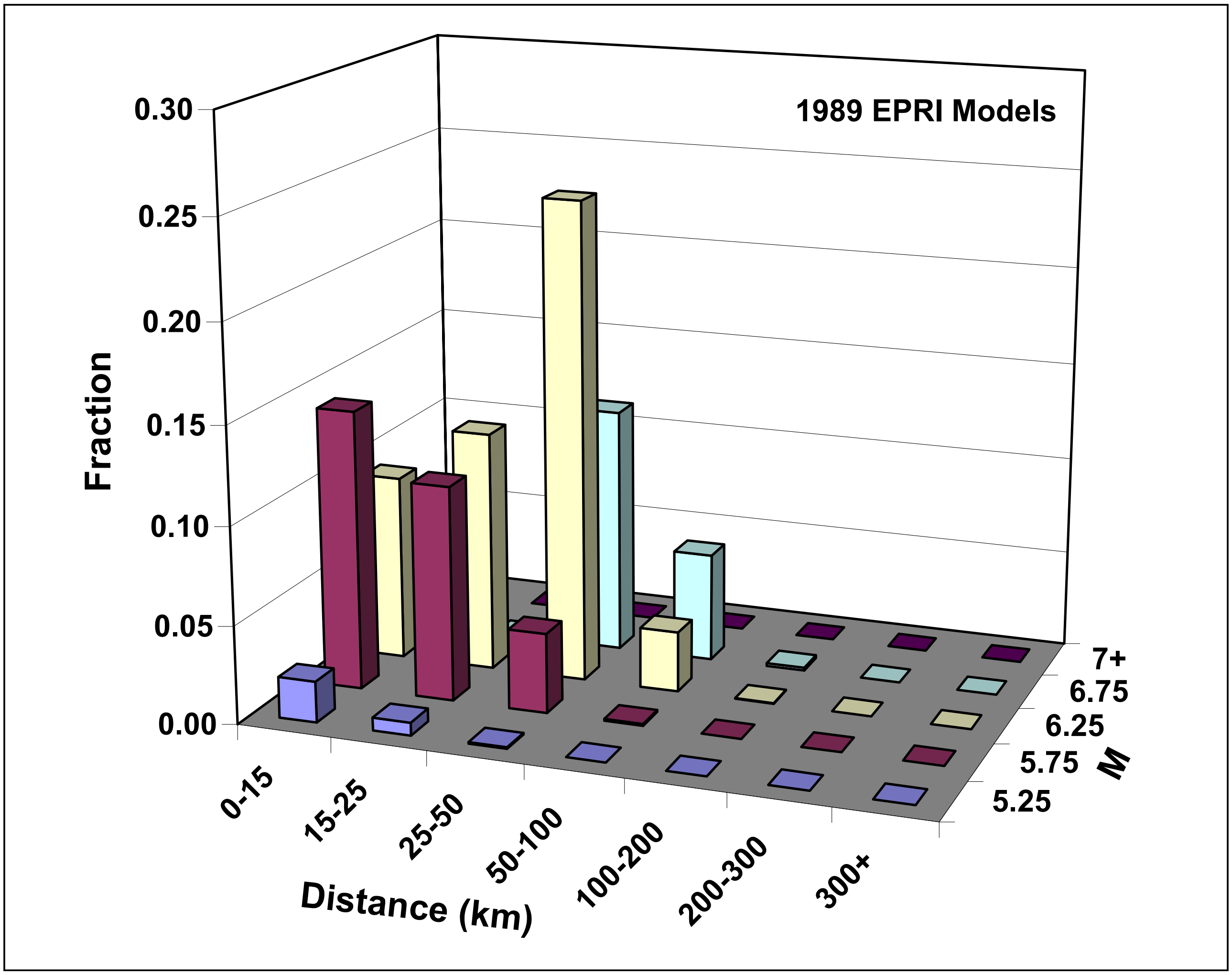


Figure 2.5-26 Low-Frequency, 10^{-5} Median, Magnitude-Distance Deaggregation Using 1989 EPRI Sources and Ground Motion

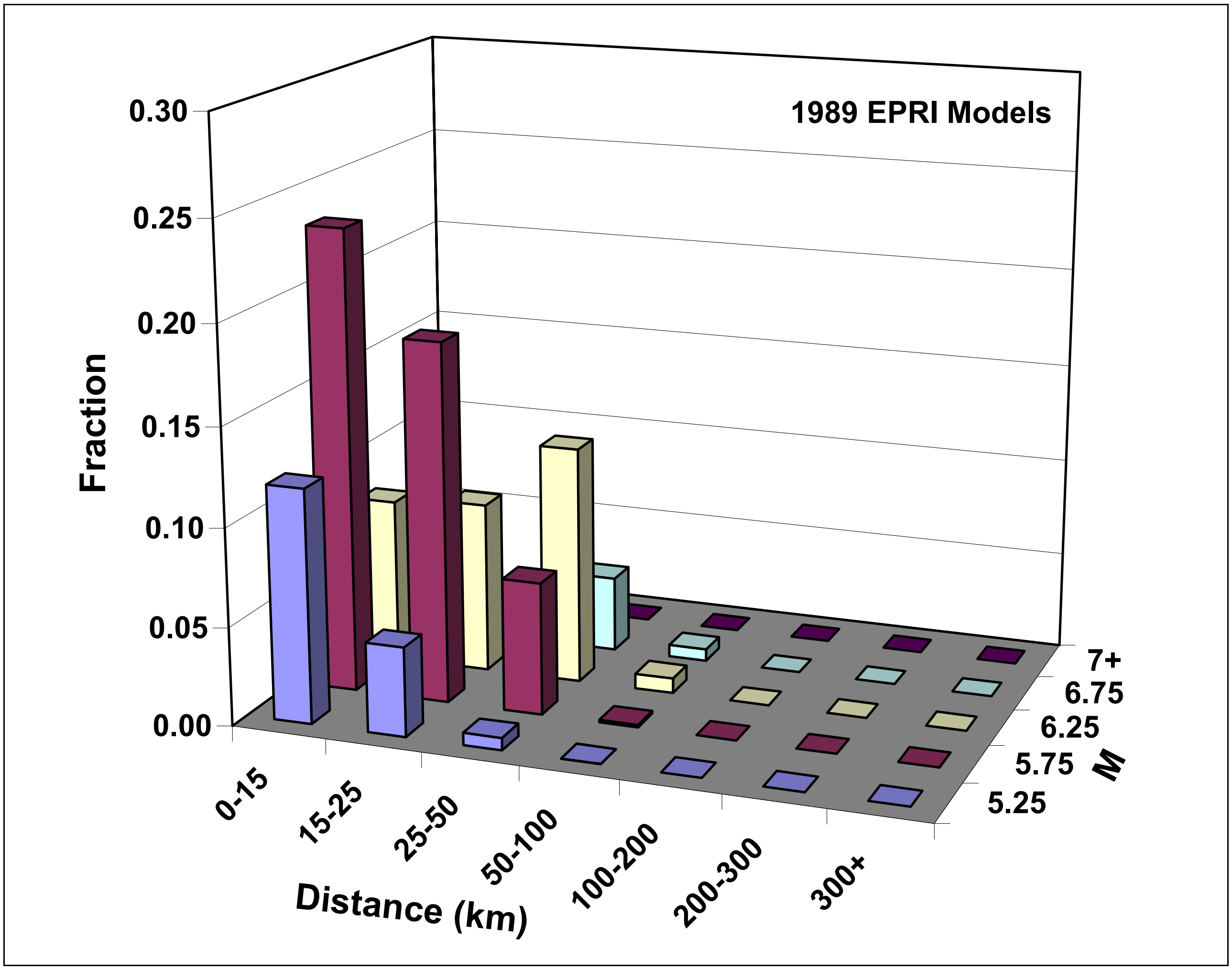


Figure 2.5-27 High-Frequency, 10^{-5} Median, Magnitude-Distance Deaggregation Using 1989 EPRI Sources and Ground Motion

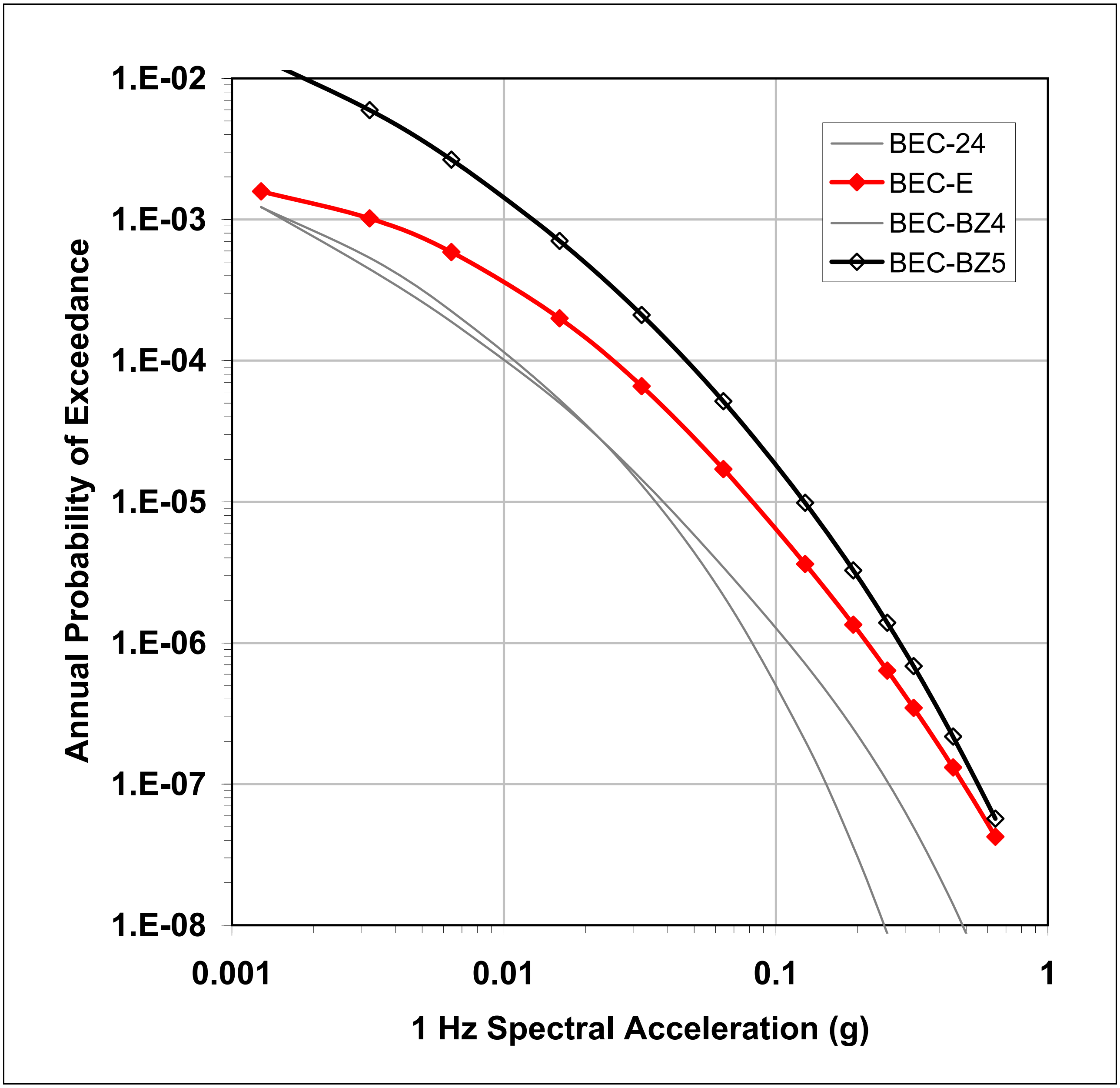


Figure 2.5-28 1989 EPRI 1 Hz Mean Hazard Contribution by Source (Bechtel); Sources Contributing Most to ESP Site Hazard Are Emphasized

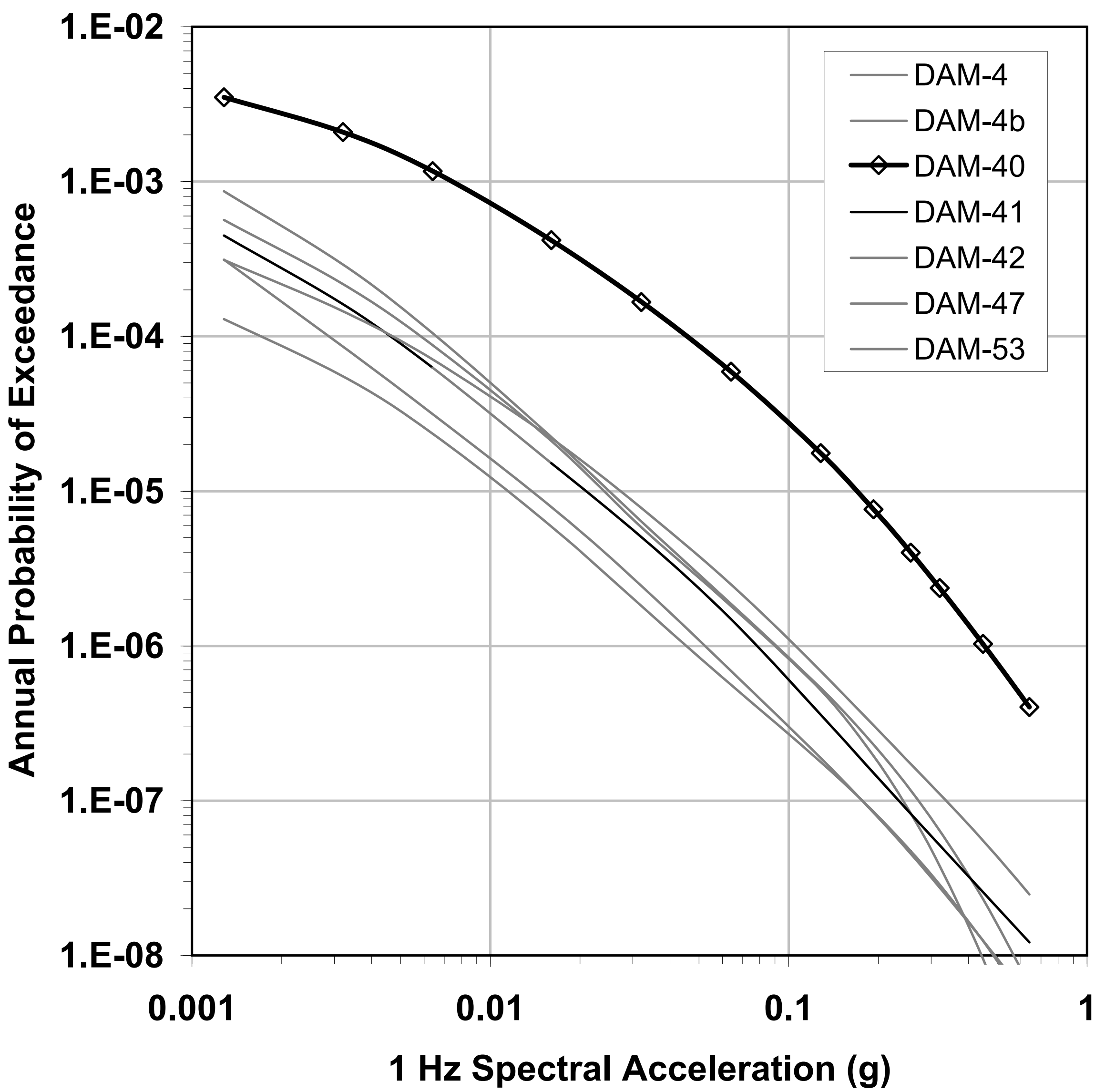


Figure 2.5-29 1989 EPRI Hazard 1 Hz Mean Contribution by Source (Dames & Moore); Sources Contributing Most to ESP Site Hazard Are Emphasized

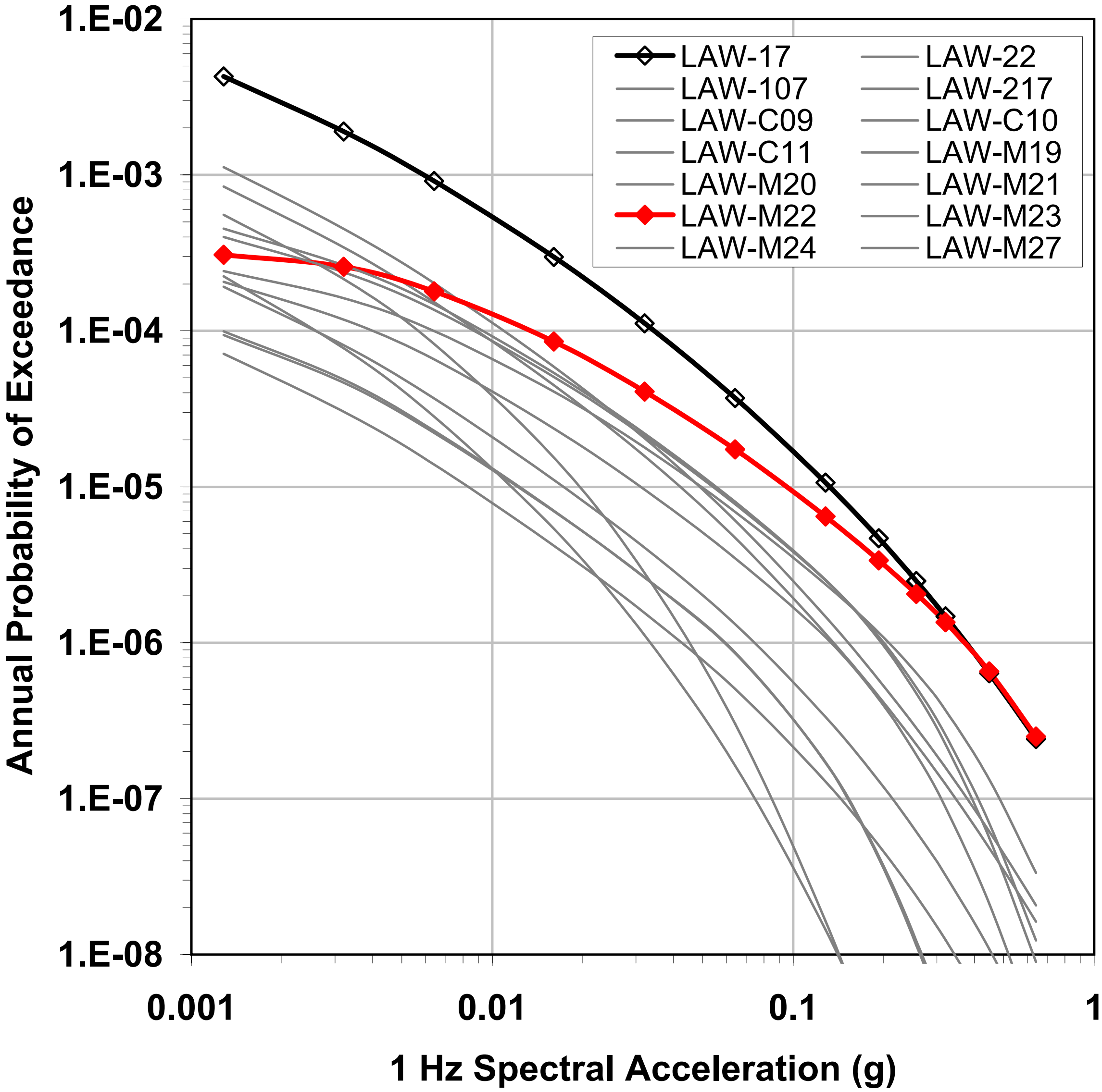


Figure 2.5-30 1989 EPRI 1 Hz Mean Hazard Contribution by Source (Law Engineering); Sources Contributing Most to ESP Site Hazard Are Emphasized

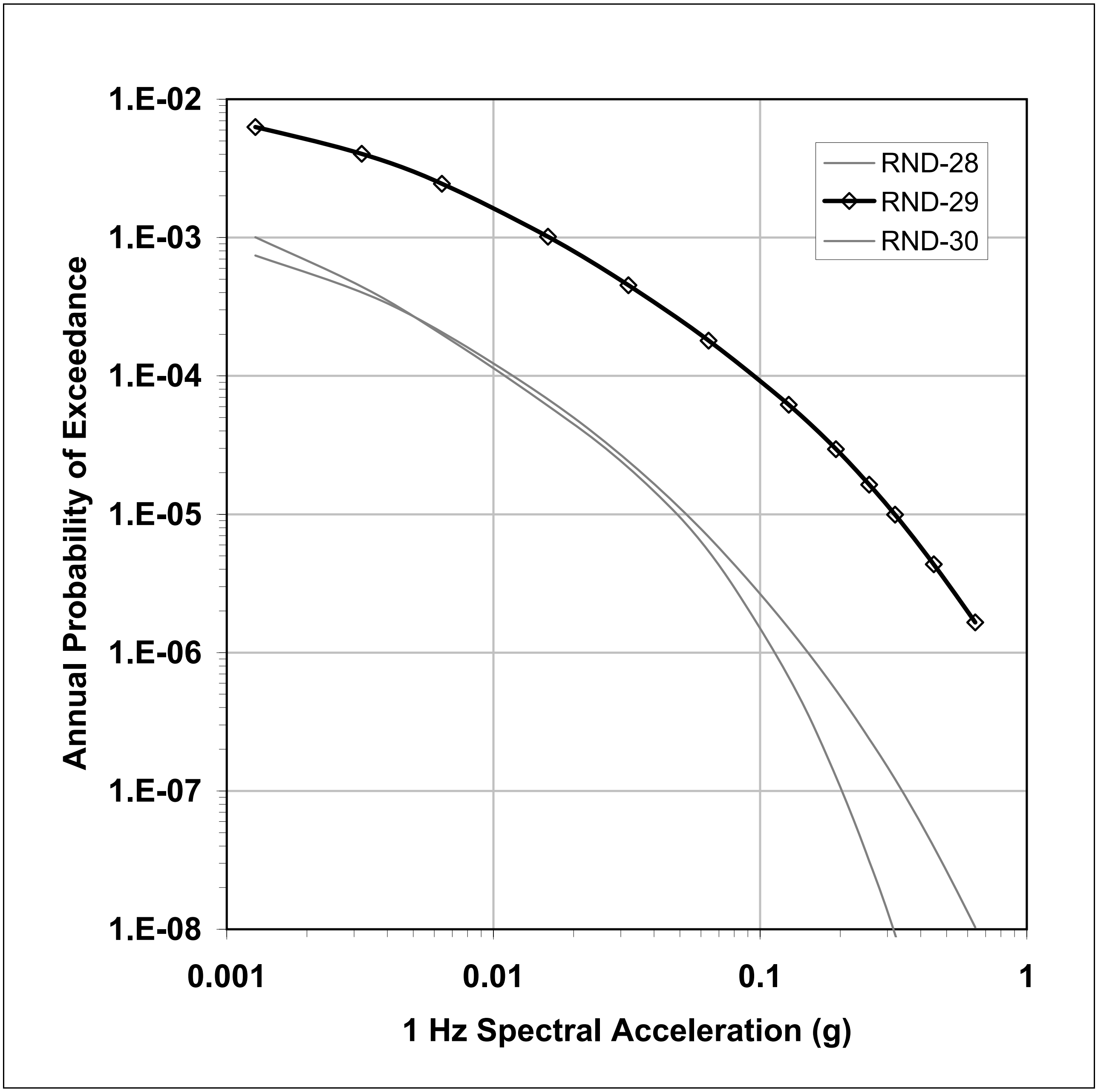


Figure 2.5-31 1989 EPRI 1 Hz Hazard Contribution by Source (Rondout Team); Sources Contributing Most to ESP Site Hazard Are Emphasized

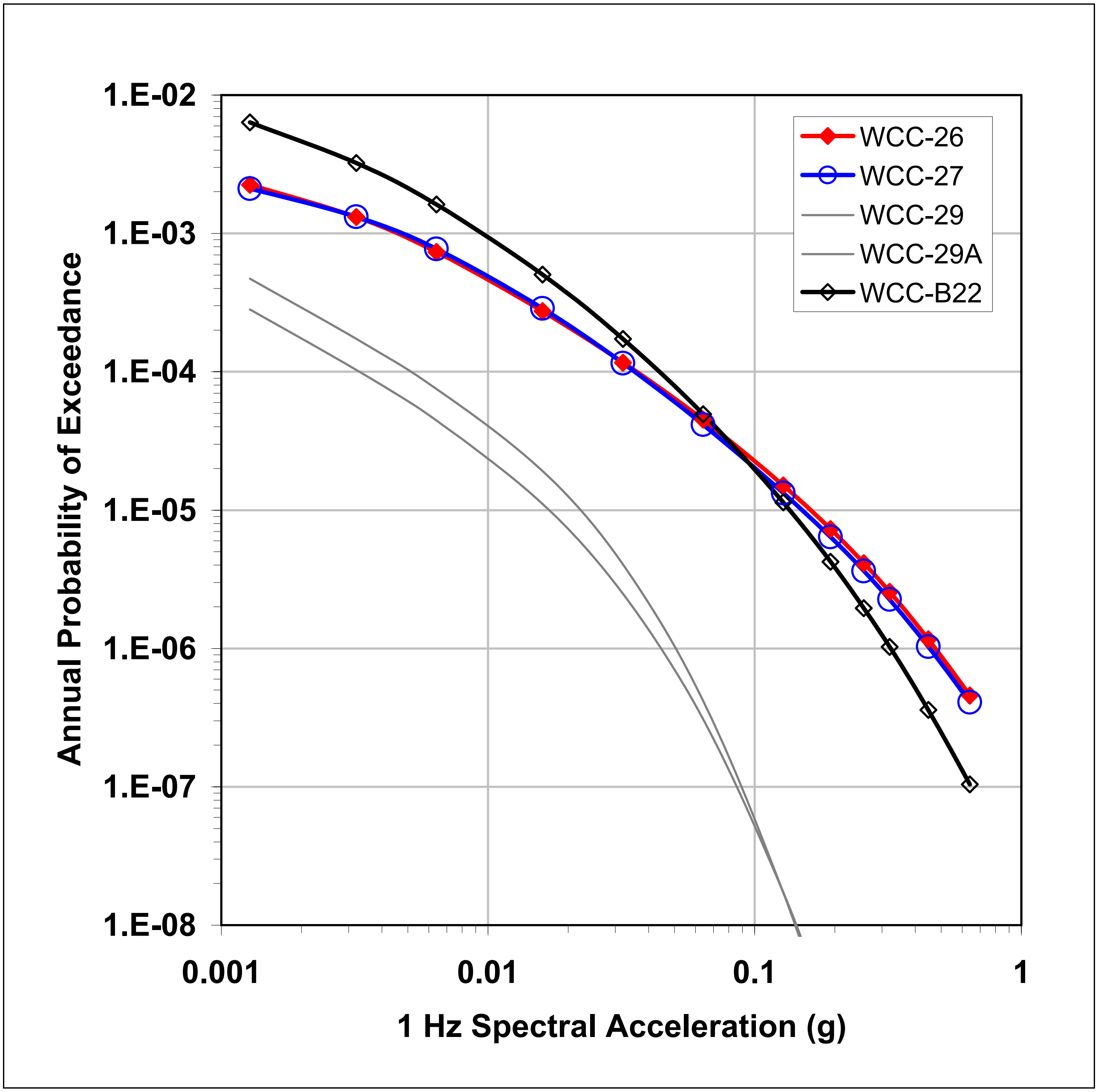


Figure 2.5-32 1989 EPRI 1 Hz Hazard Contribution by Source (Woodward-Clyde); Sources Contributing Most to ESP Site Hazard Are Emphasized

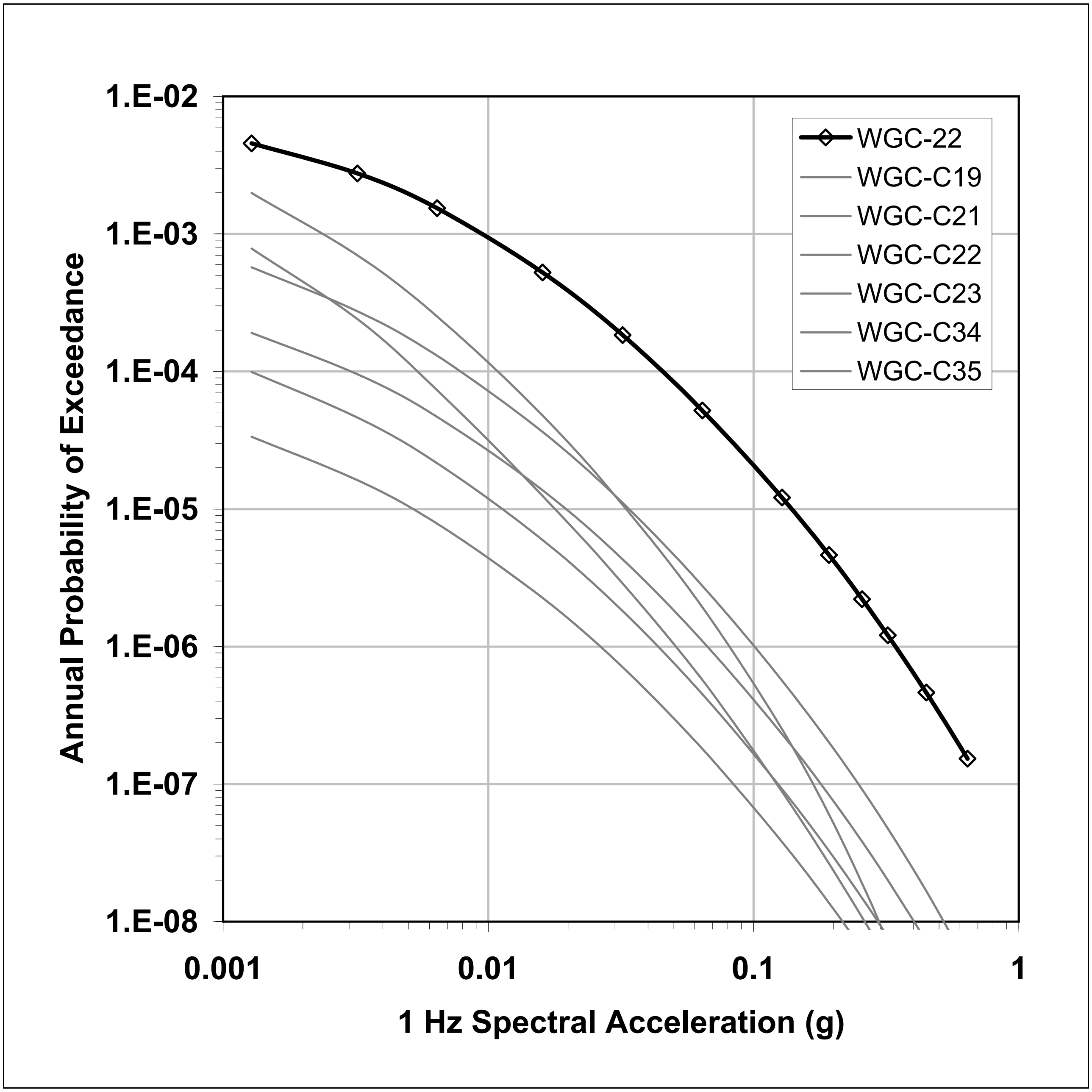


Figure 2.5-33 1989 EPRI 1 Hz Hazard Contribution by Source (Weston Geophysical); Sources Contributing Most to ESP Site Hazard Are Emphasized

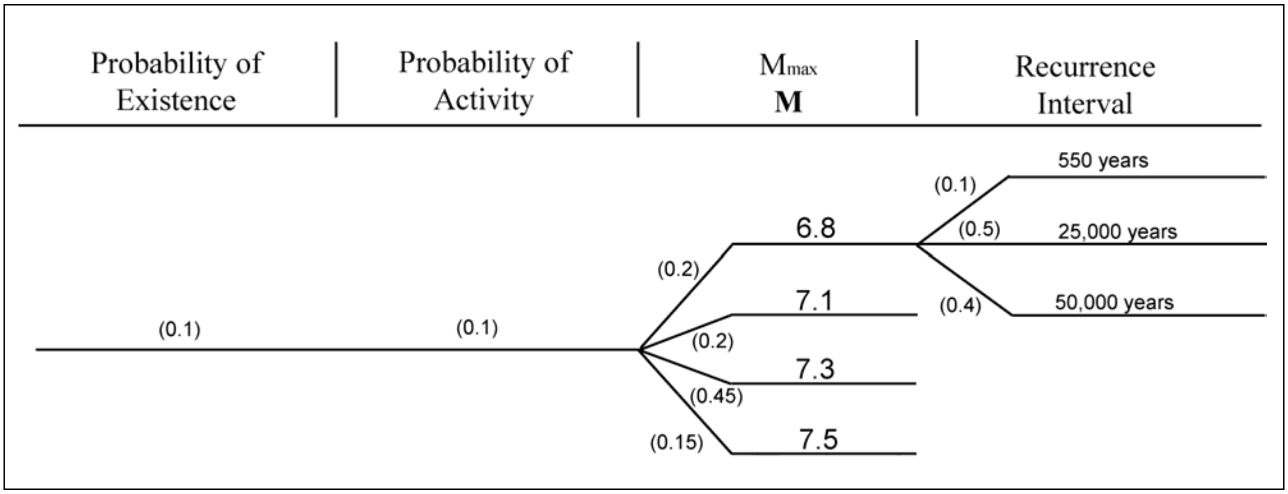


Figure 2.5-34 Logic Tree for ECFS Northern Segment

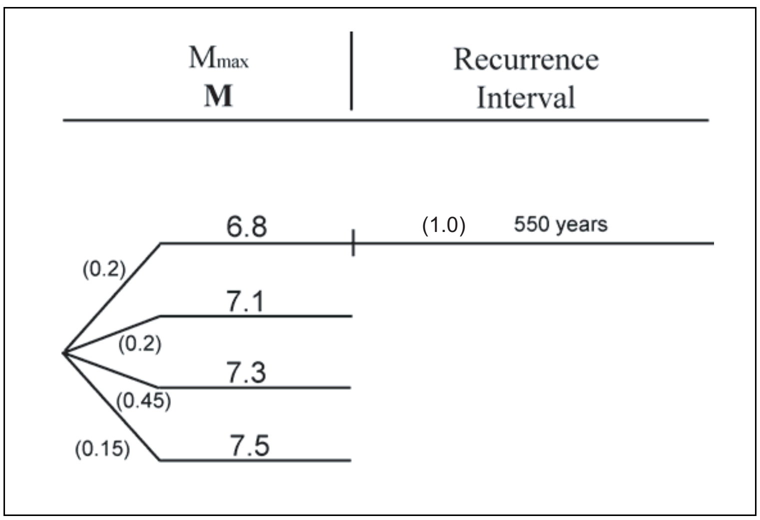


Figure 2.5-35 Logic Tree for the Updated Charleston Source (ECFS Southern Segment)

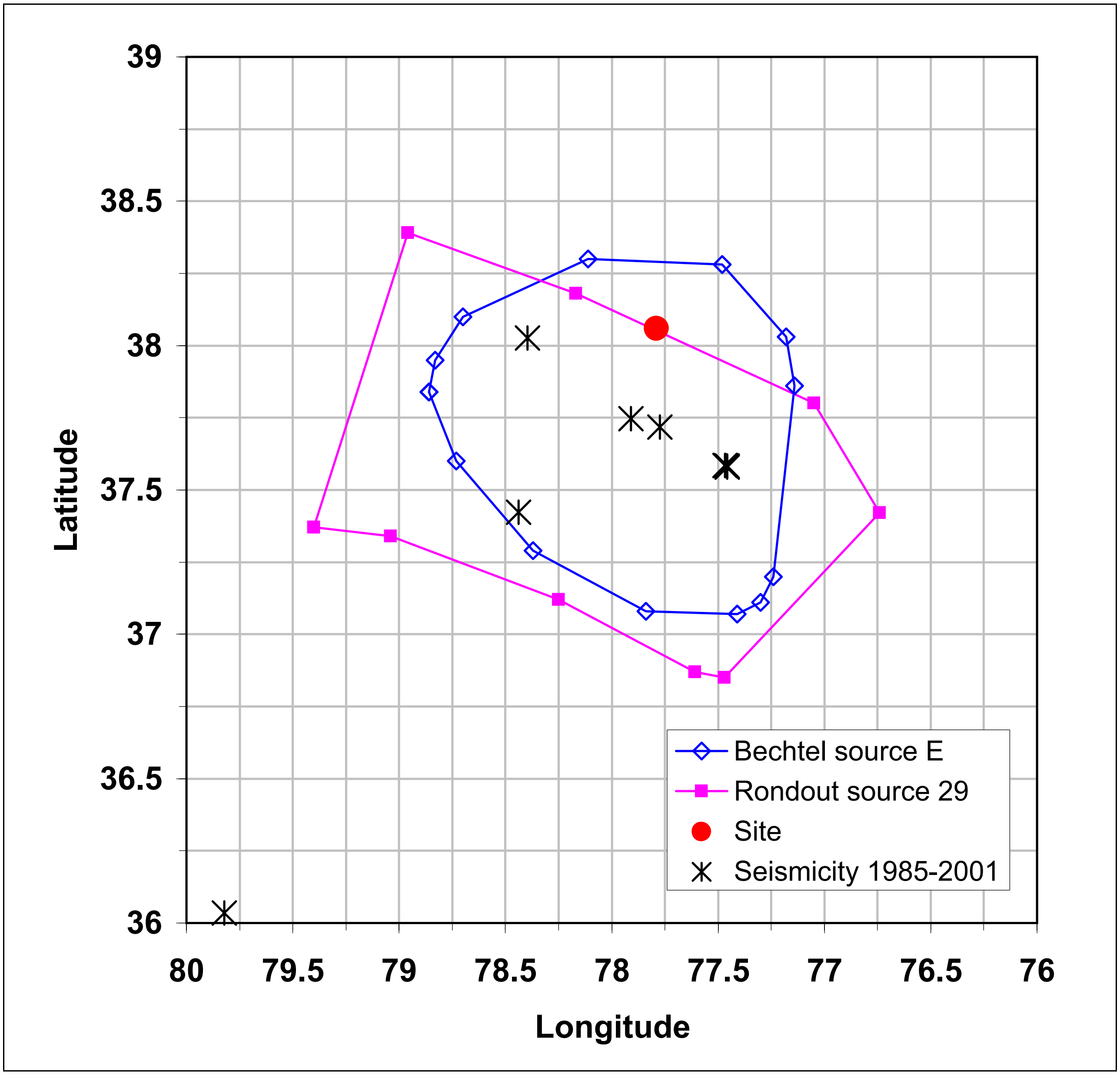


Figure 2.5-36 Bechtel and Rondout Team Representations of Central Virginia Seismic Zone, and Seismicity in the Region Recorded from 1985 to 2001

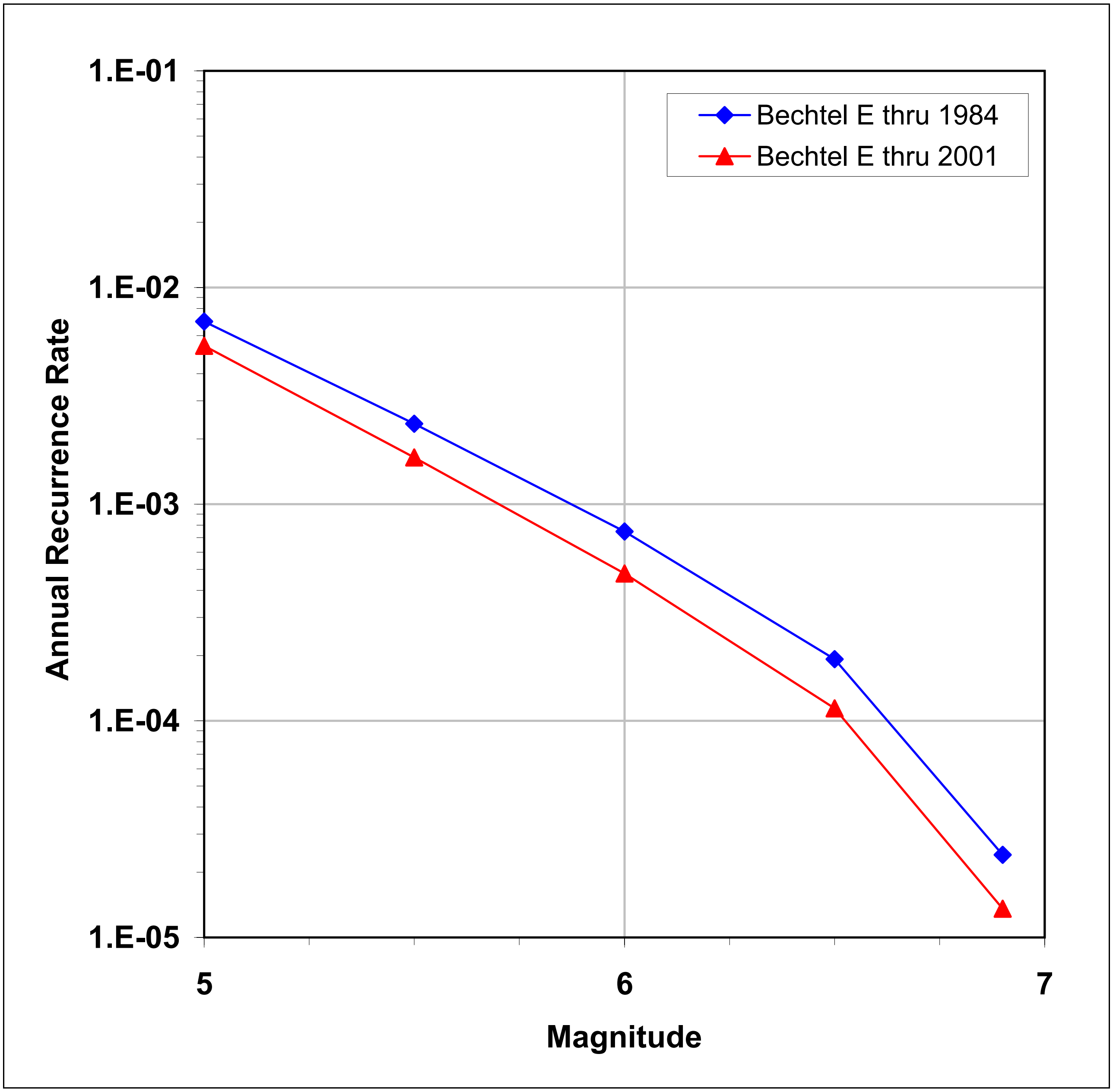


Figure 2.5-37 Comparison of Seismic Activity Rates for Bechtel Source E Considering Original EPRI (through 1984) and Updated (through 2001) Earthquake Catalogs

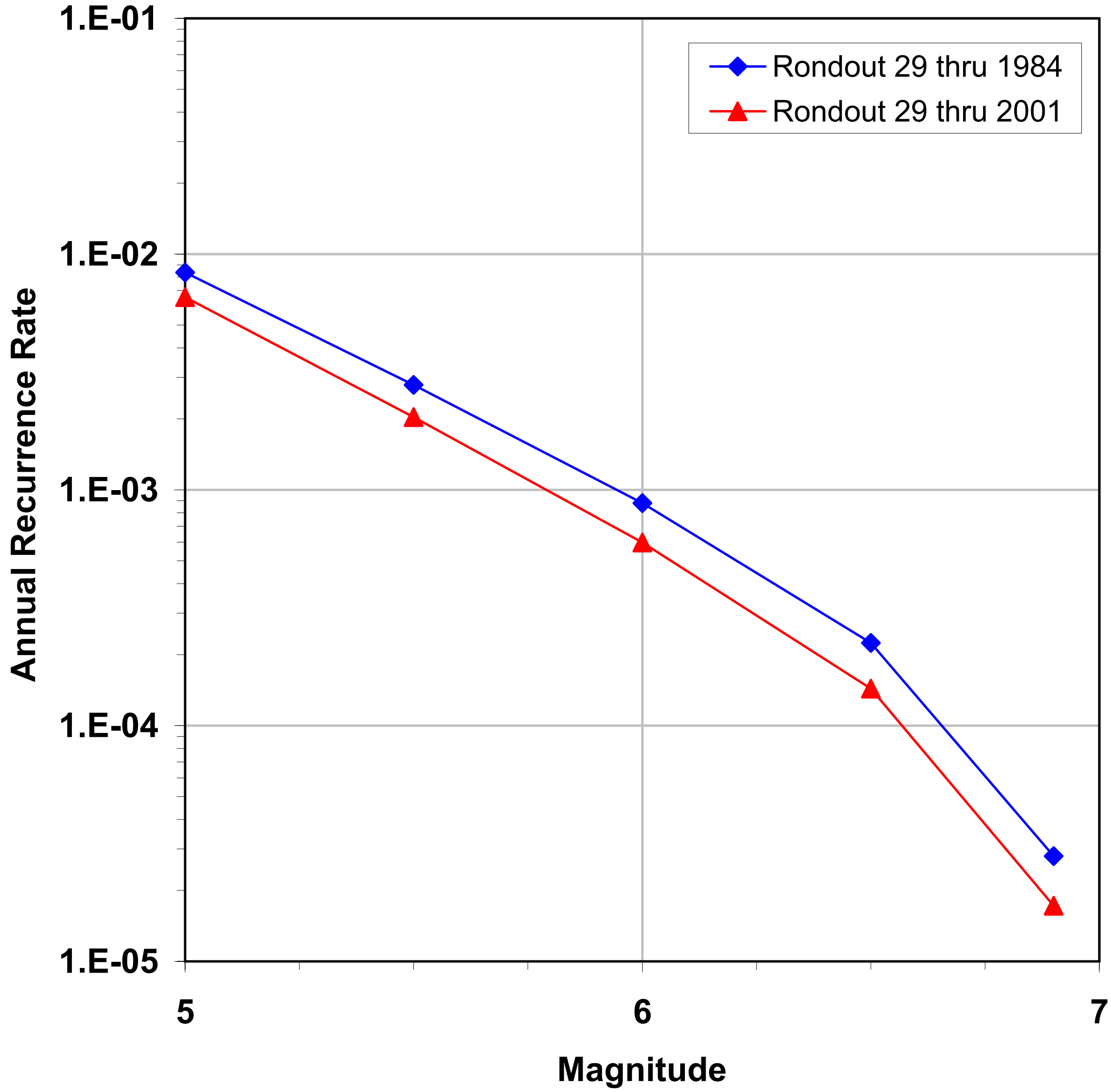


Figure 2.5-38 Comparison of Seismic Activity for Rondout Source 29 Considering Original EPRI (through 1984) and Updated (through 2001) Earthquake Catalogs

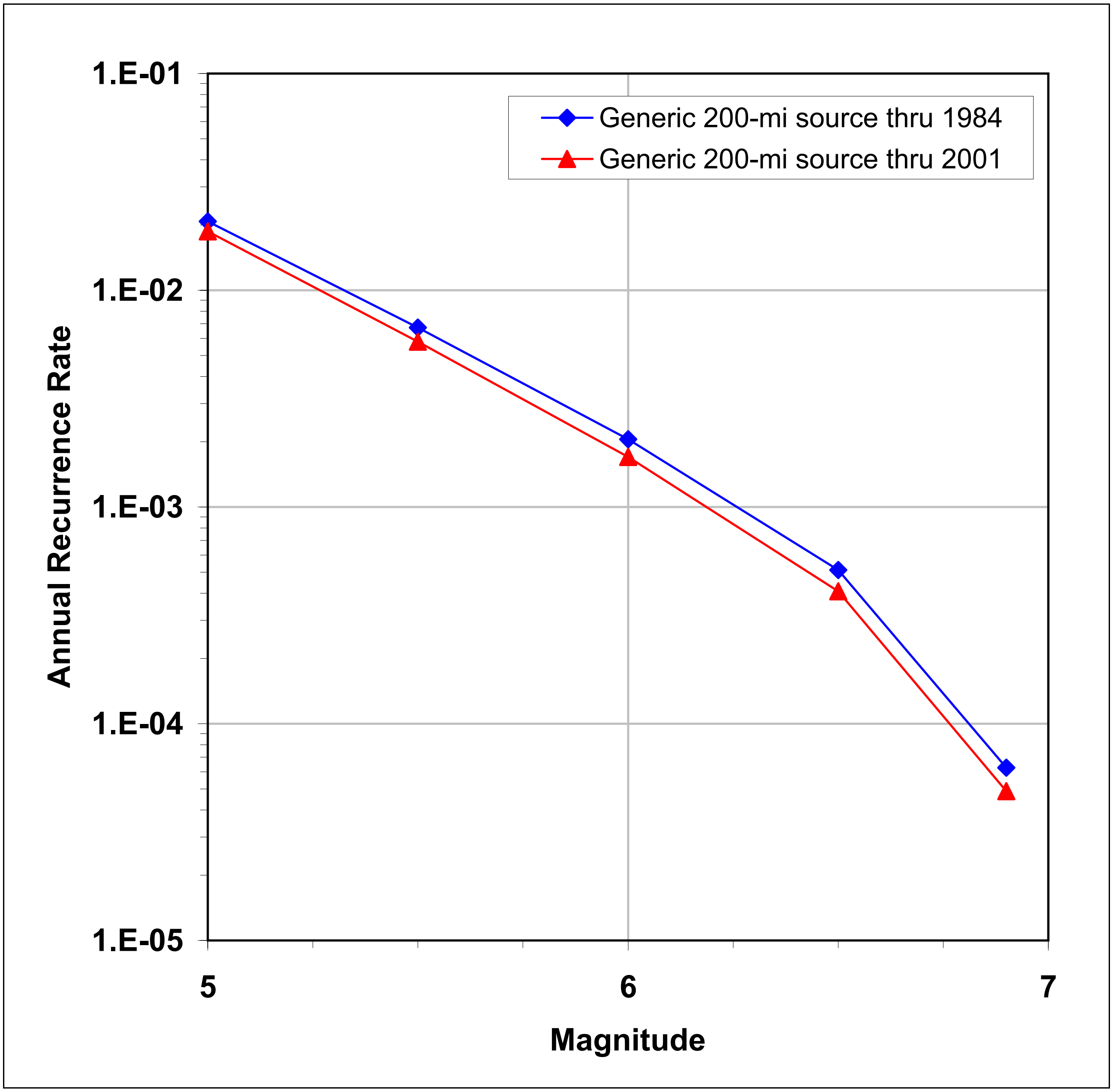


Figure 2.5-39 Comparison of Seismic Activity for 200-Mile Radius Source Around North Anna Considering Original EPRI (through 1984) and Updated (through 2001) Earthquake Catalogs

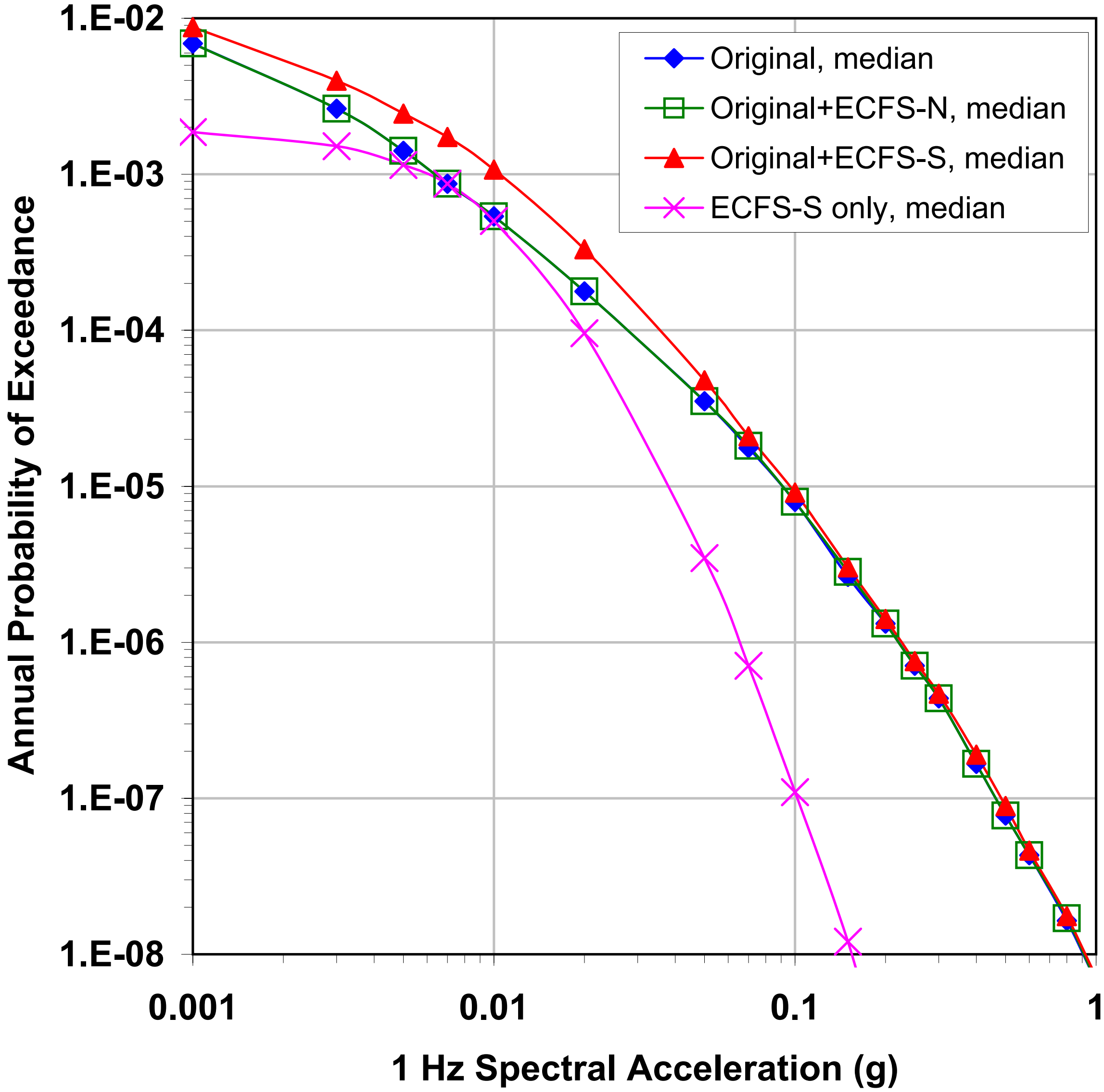


Figure 2.5-40 Effect of ECFS Faults on Median, 1 Hz Seismic Hazard

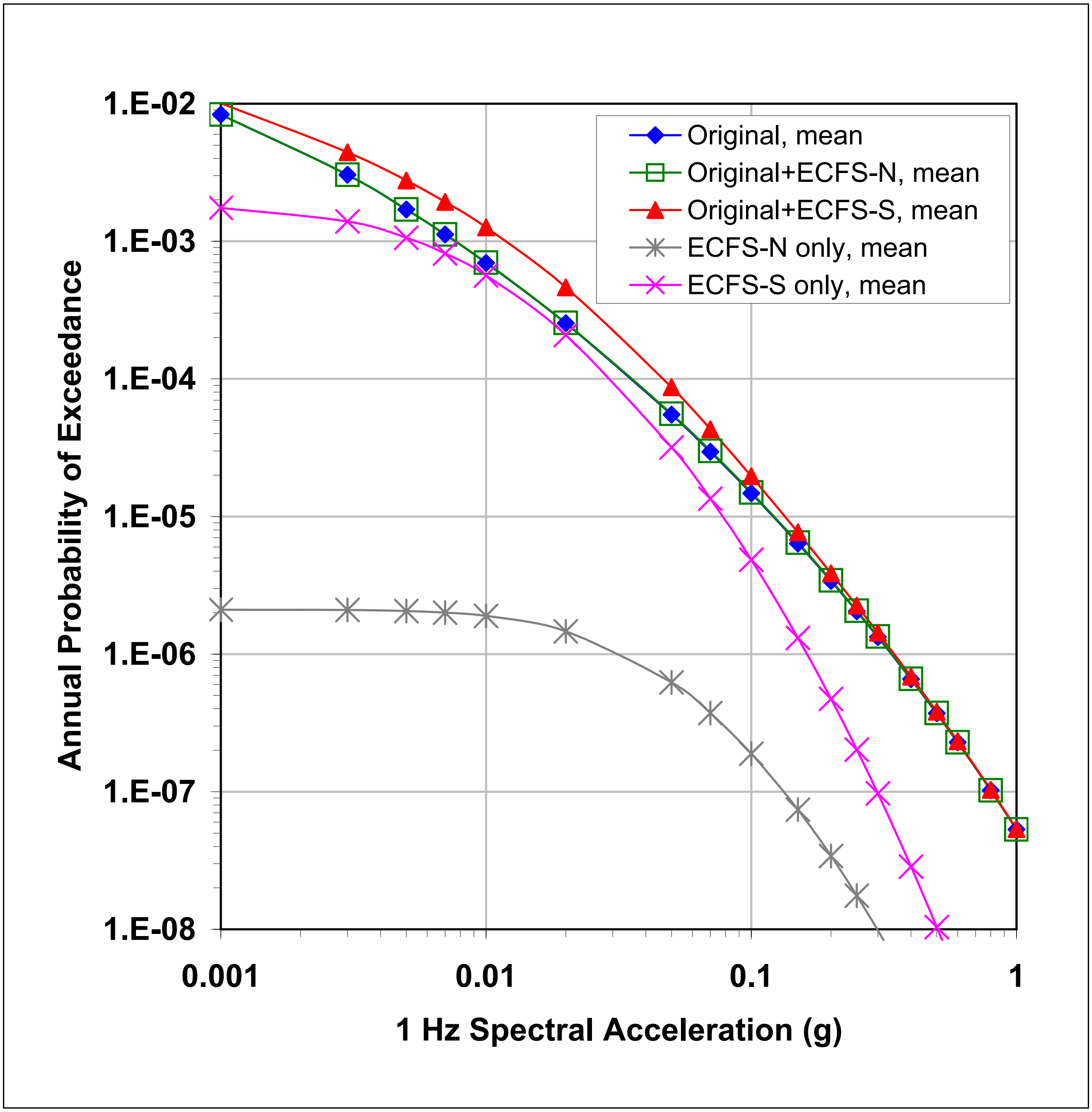


Figure 2.5-41 Effect of ECFS Faults on Mean, 1 Hz Seismic Hazard

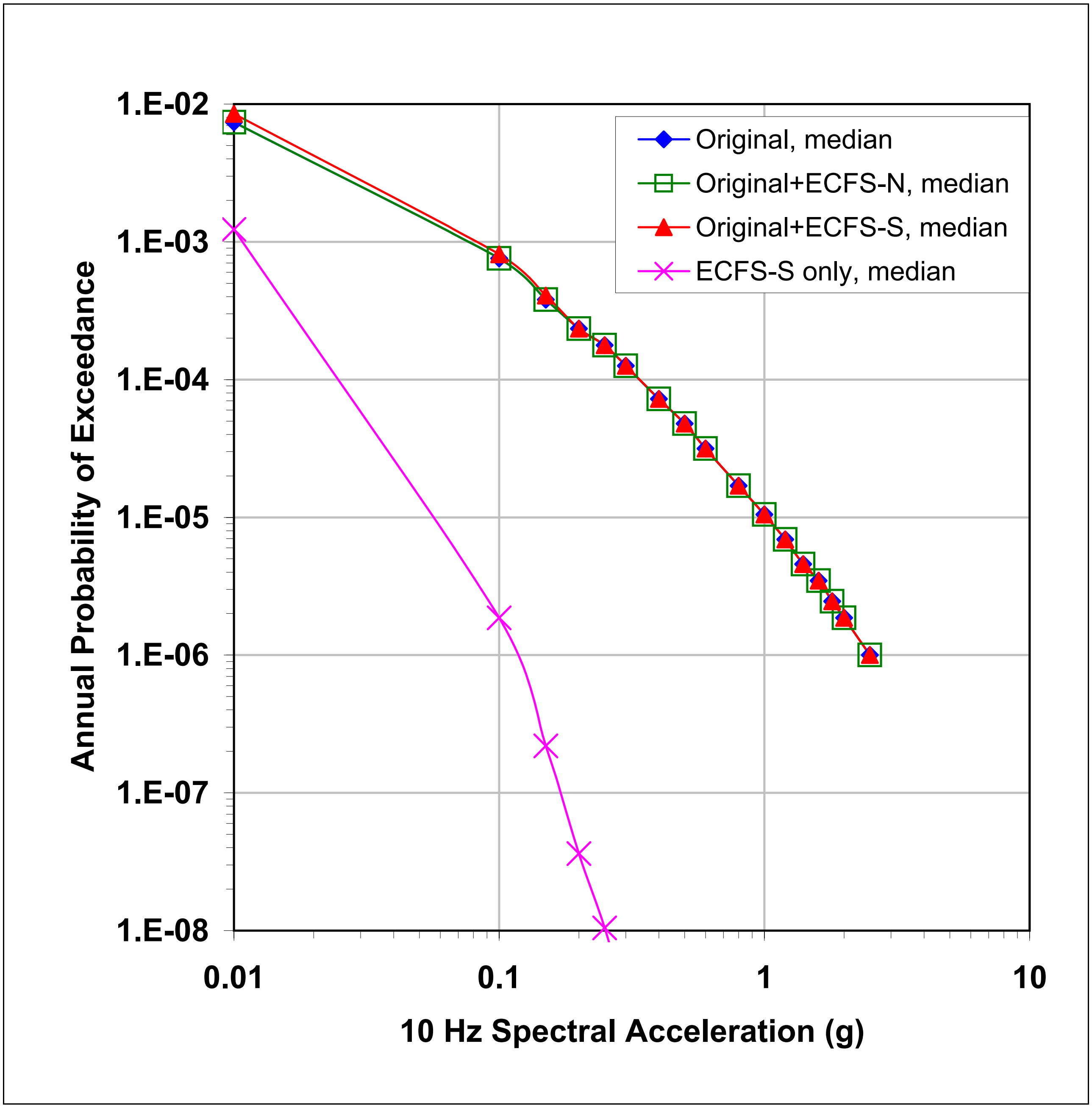


Figure 2.5-42 Effect of ECFS Faults on Median, 10 Hz Seismic Hazard

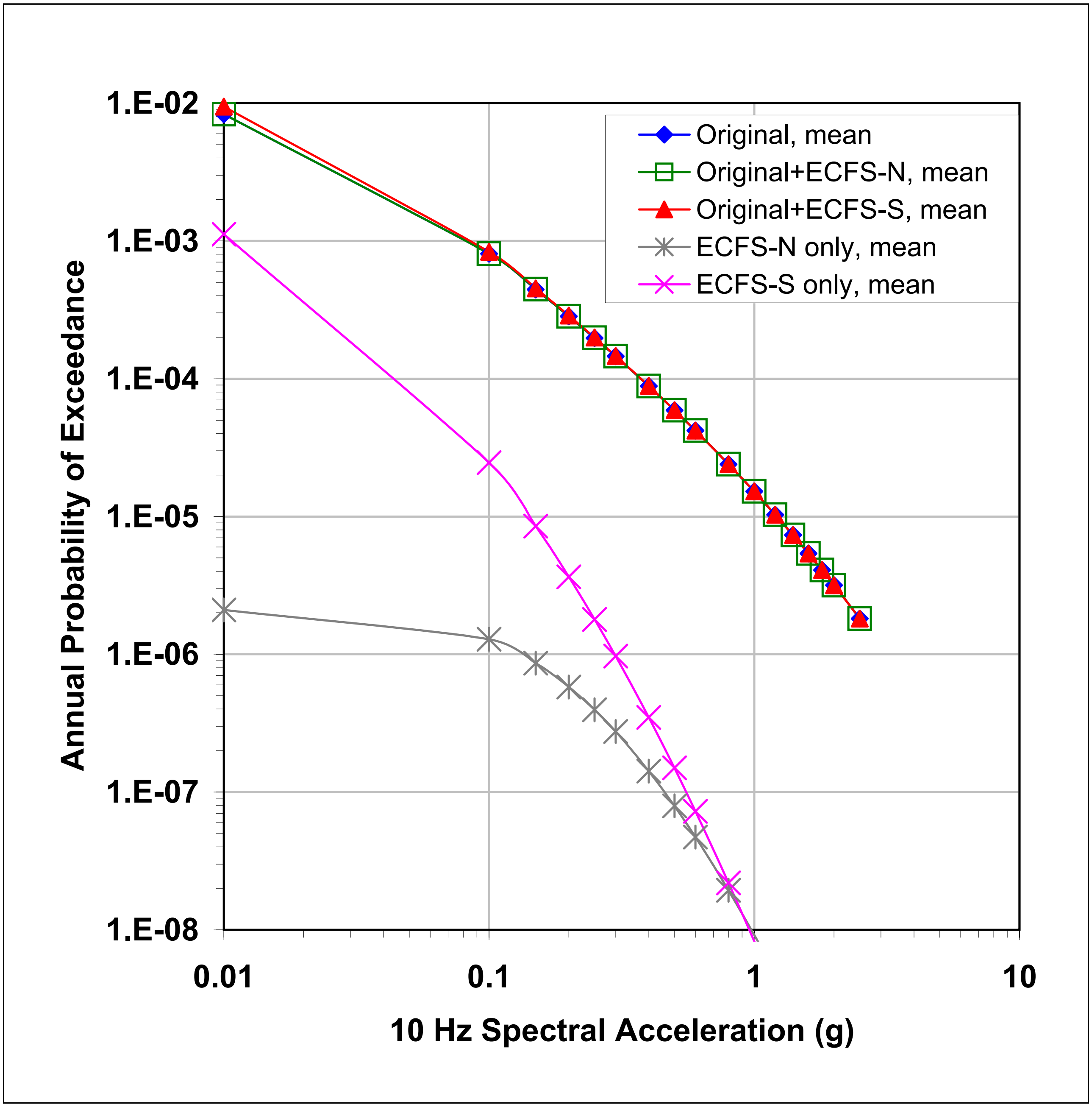


Figure 2.5-43 Effect of ECFS Faults on Mean, 10 Hz Seismic Hazard

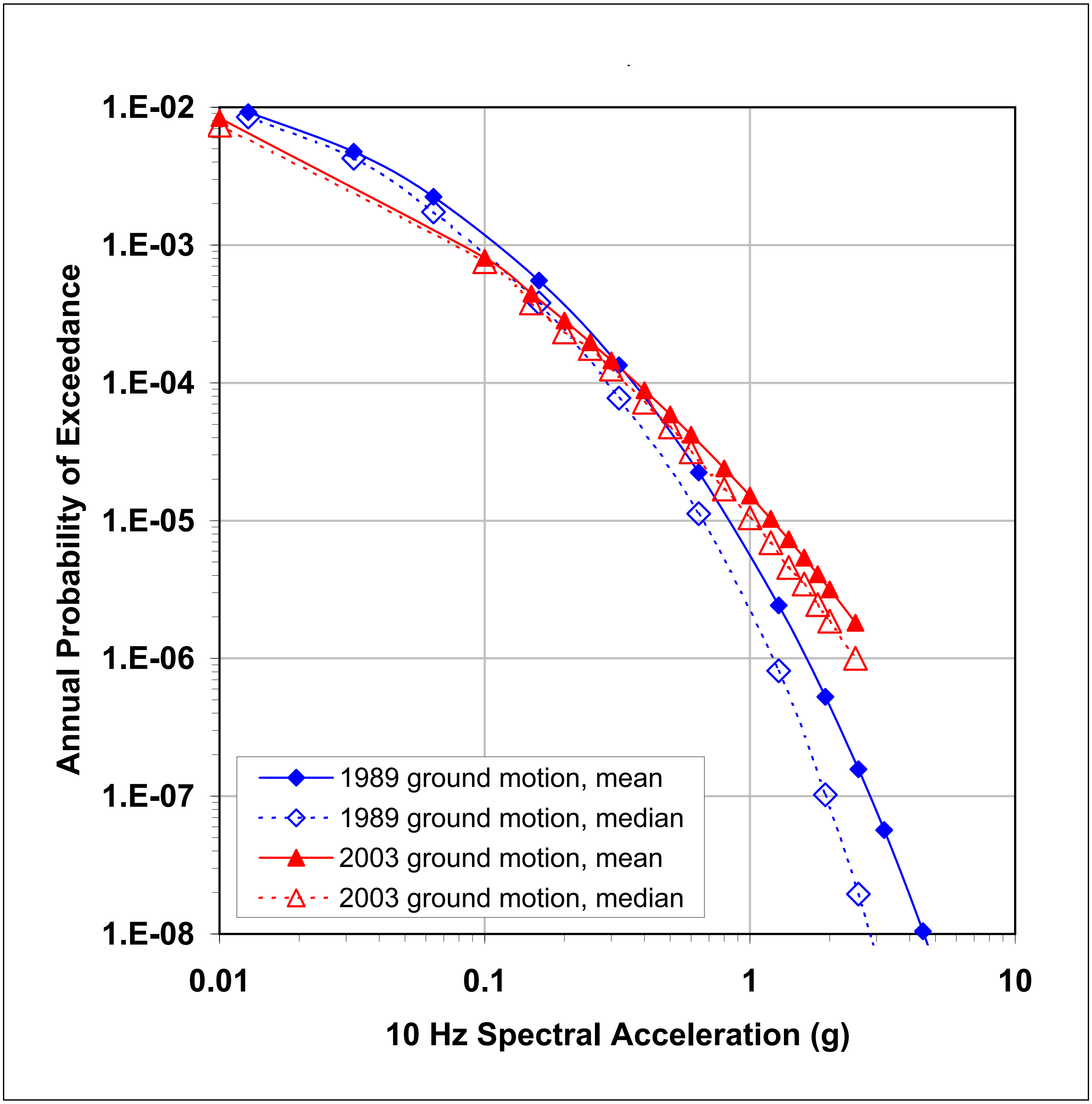


Figure 2.5-44 Sensitivity of 10 Hz Seismic Hazard to 1989 and 2003 Ground Motion Models

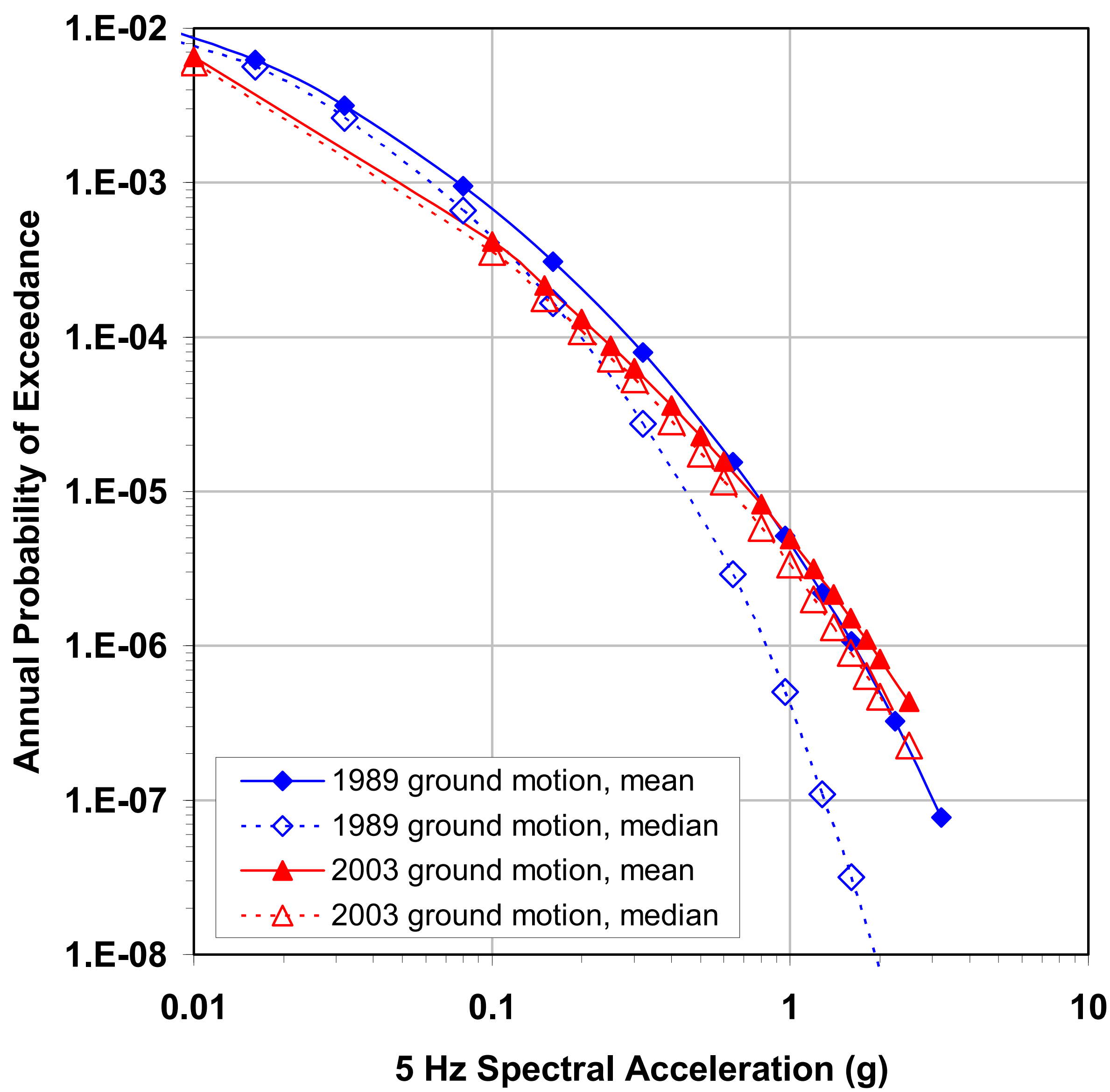


Figure 2.5-44A Sensitivity of 5 Hz Seismic Hazard to 1989 and 2003 Ground Motion Models

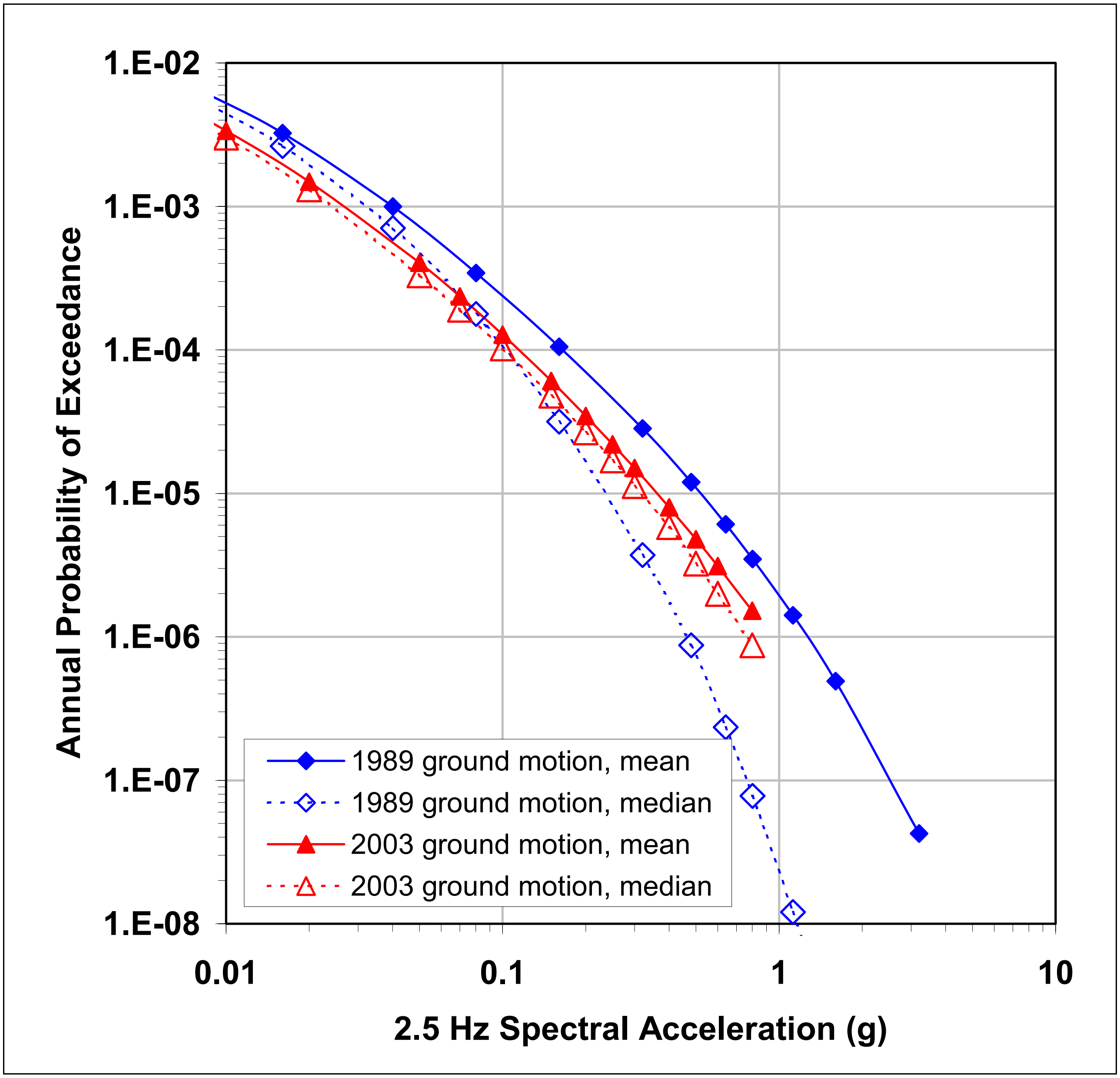


Figure 2.5-44B Sensitivity of 2.5 Hz Seismic Hazard to 1989 and 2003 Ground Motion Models

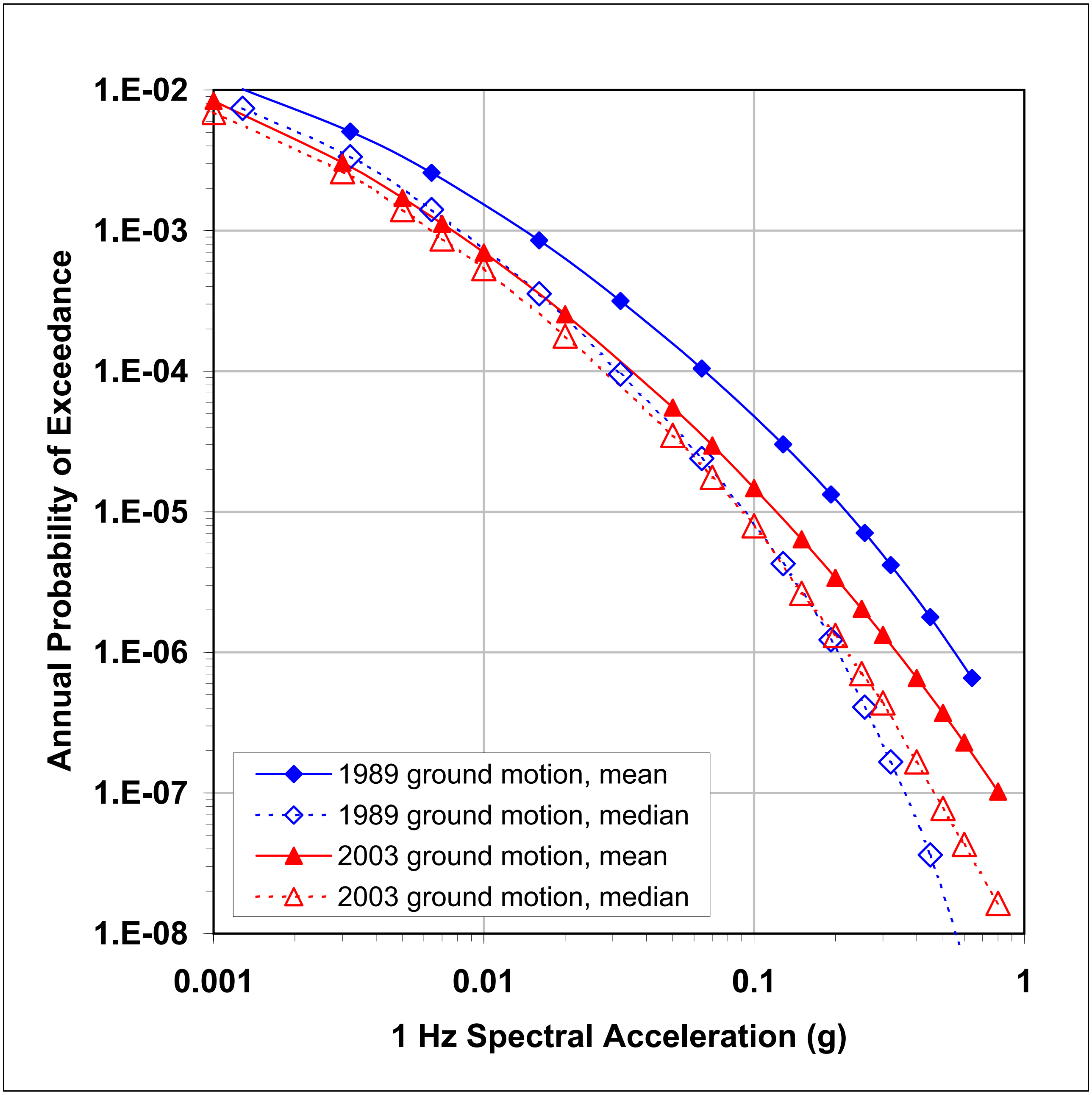


Figure 2.5-45 Sensitivity of 1 Hz Seismic Hazard to 1989 and 2003 Ground Motion Models

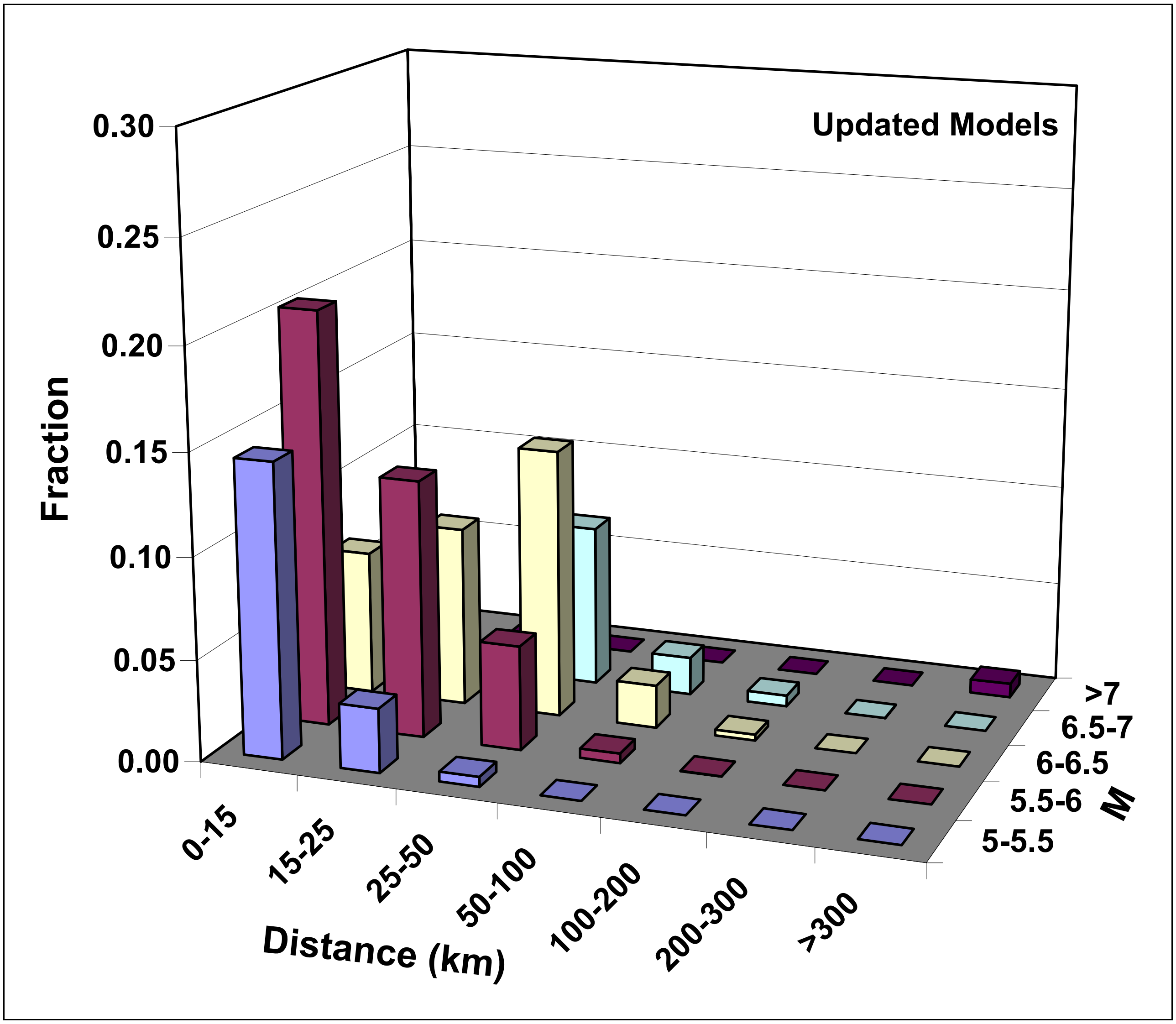


Figure 2.5-46 Low-Frequency, 10^{-5} Median, Magnitude-Distance Deaggregation Using Updated Source and Ground Motion Models

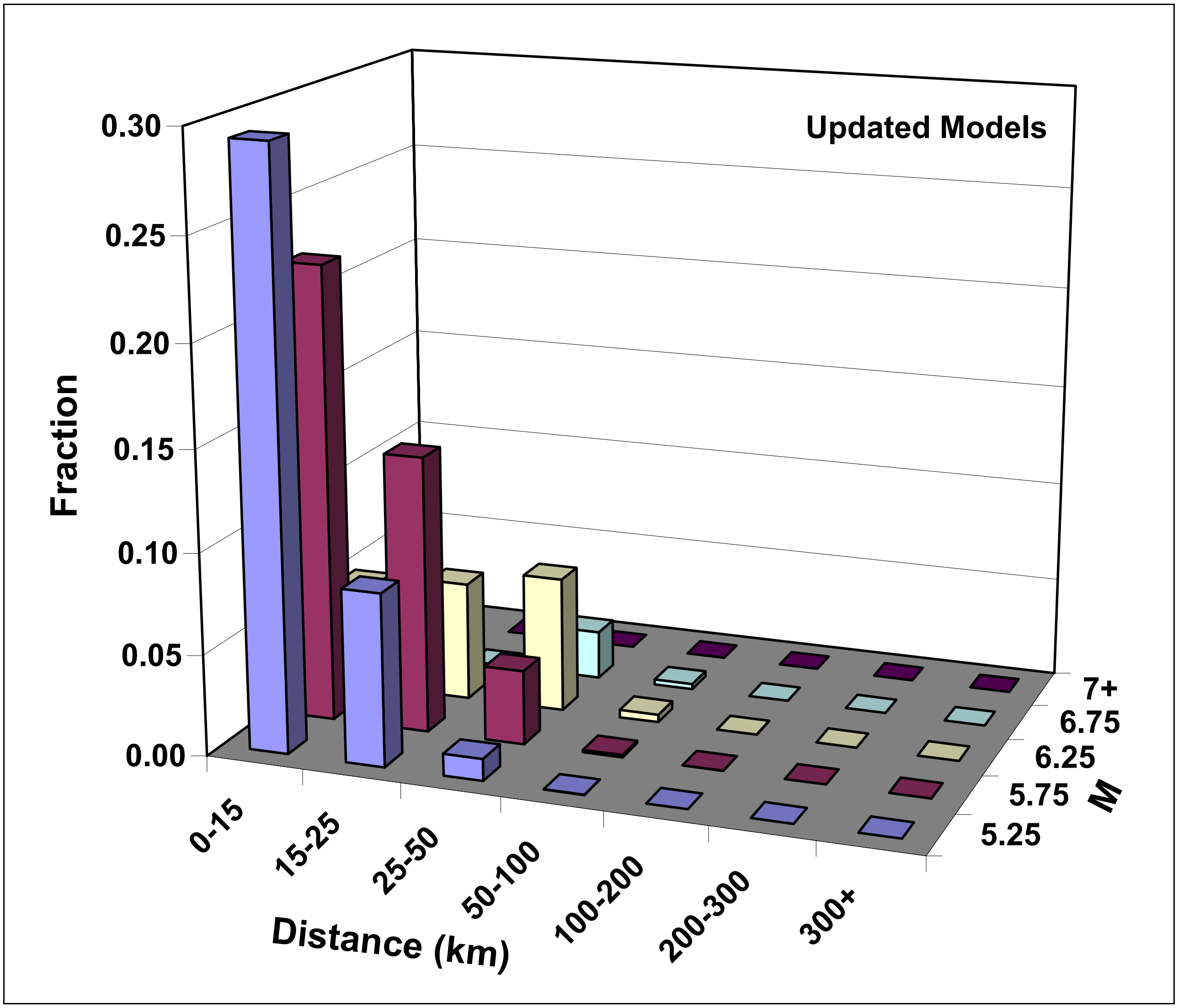


Figure 2.5-47 High-Frequency, 10^{-5} Median, Magnitude-Distance Deaggregation Using Updated Source and Ground Motion Models

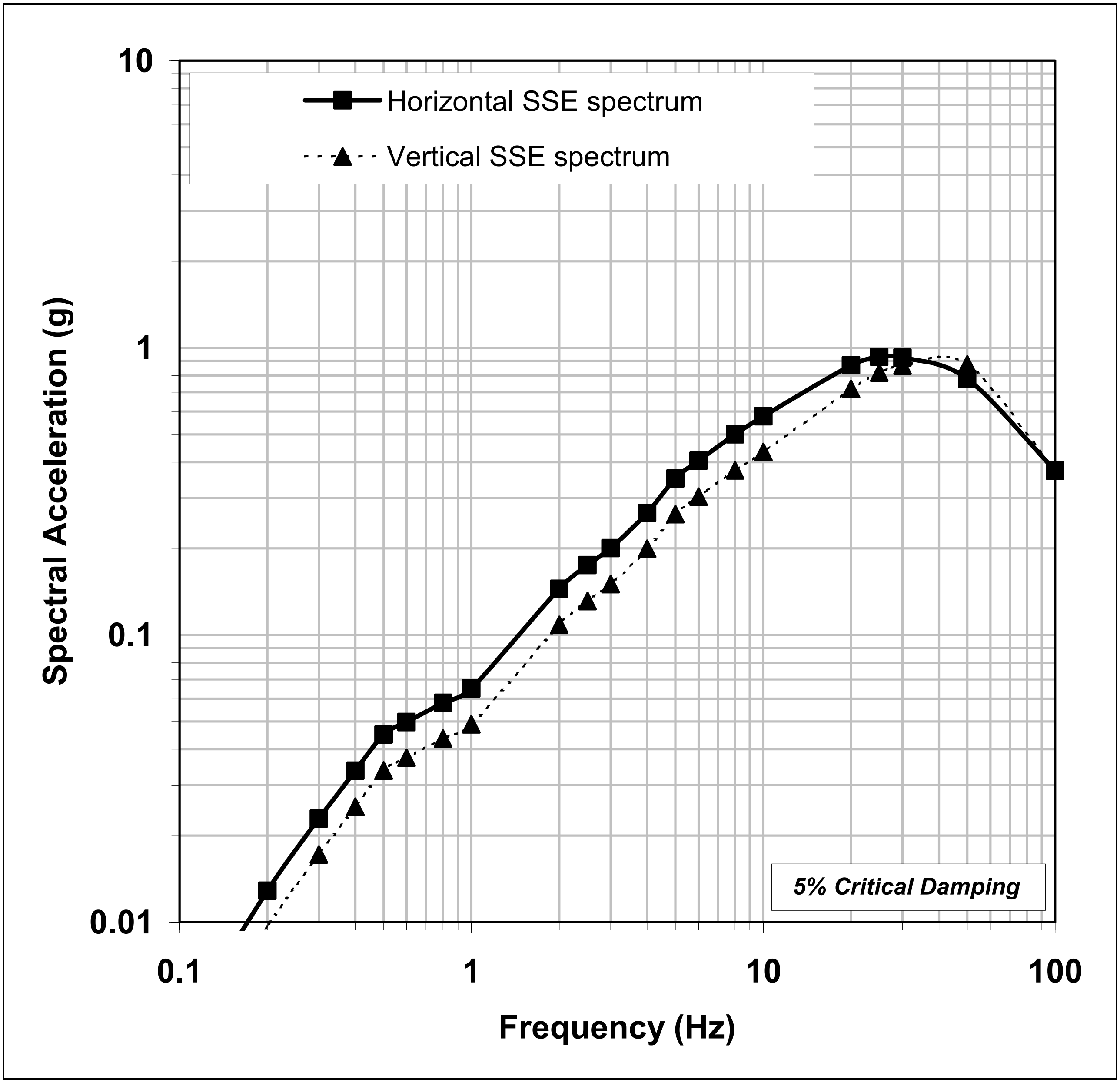


Figure 2.5-48 Selected Horizontal and Vertical Hard Rock SSE Spectra for the North Anna ESP Site

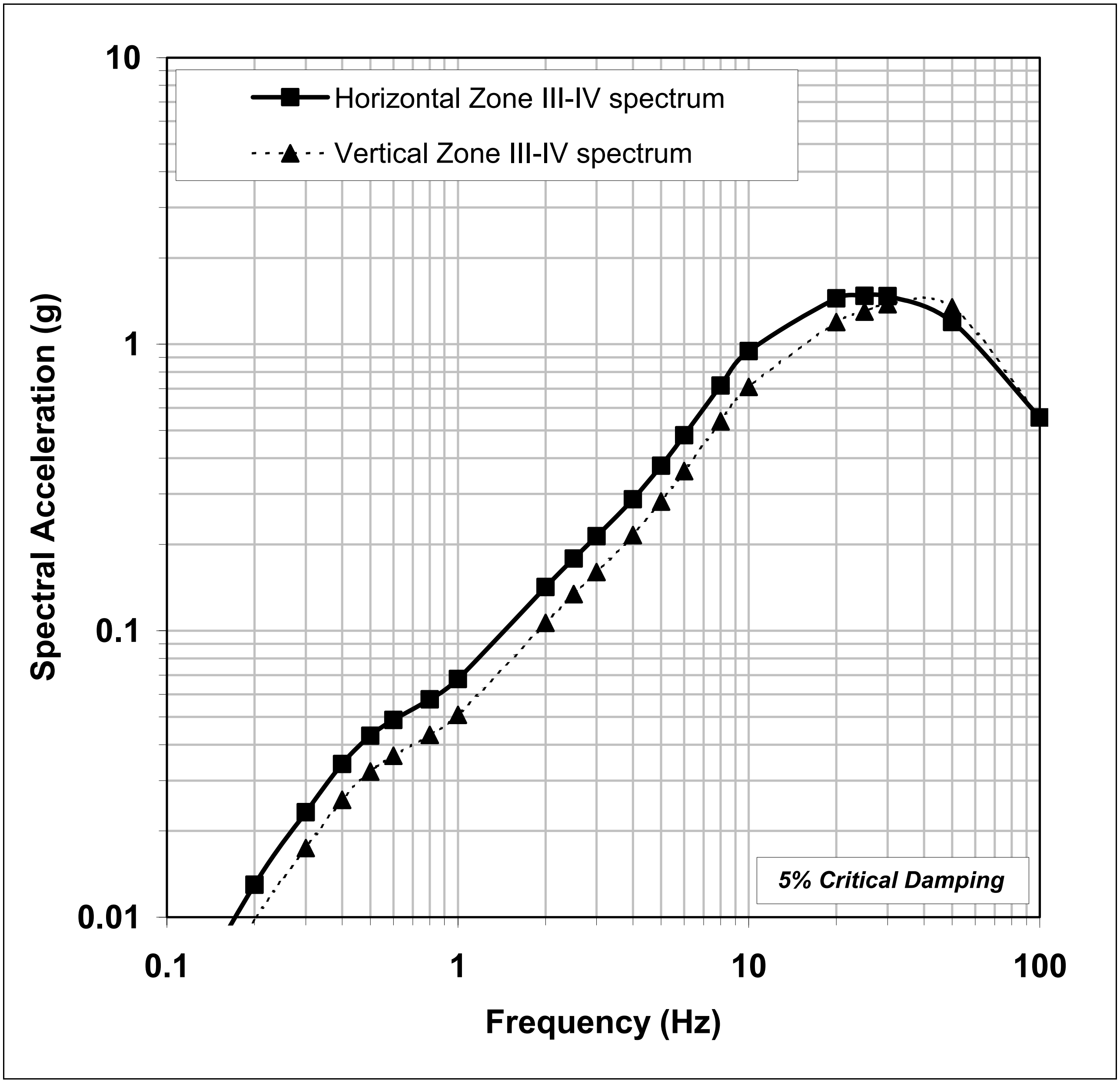


Figure 2.5-48A Selected Horizontal and Vertical Response Spectra for the Hypothetical Rock Outcrop Control Point SSE at the Top of Zone III-IV Material (Representative Elevation 250 ft, 3,300 ft/sec Shear Wave Velocity)

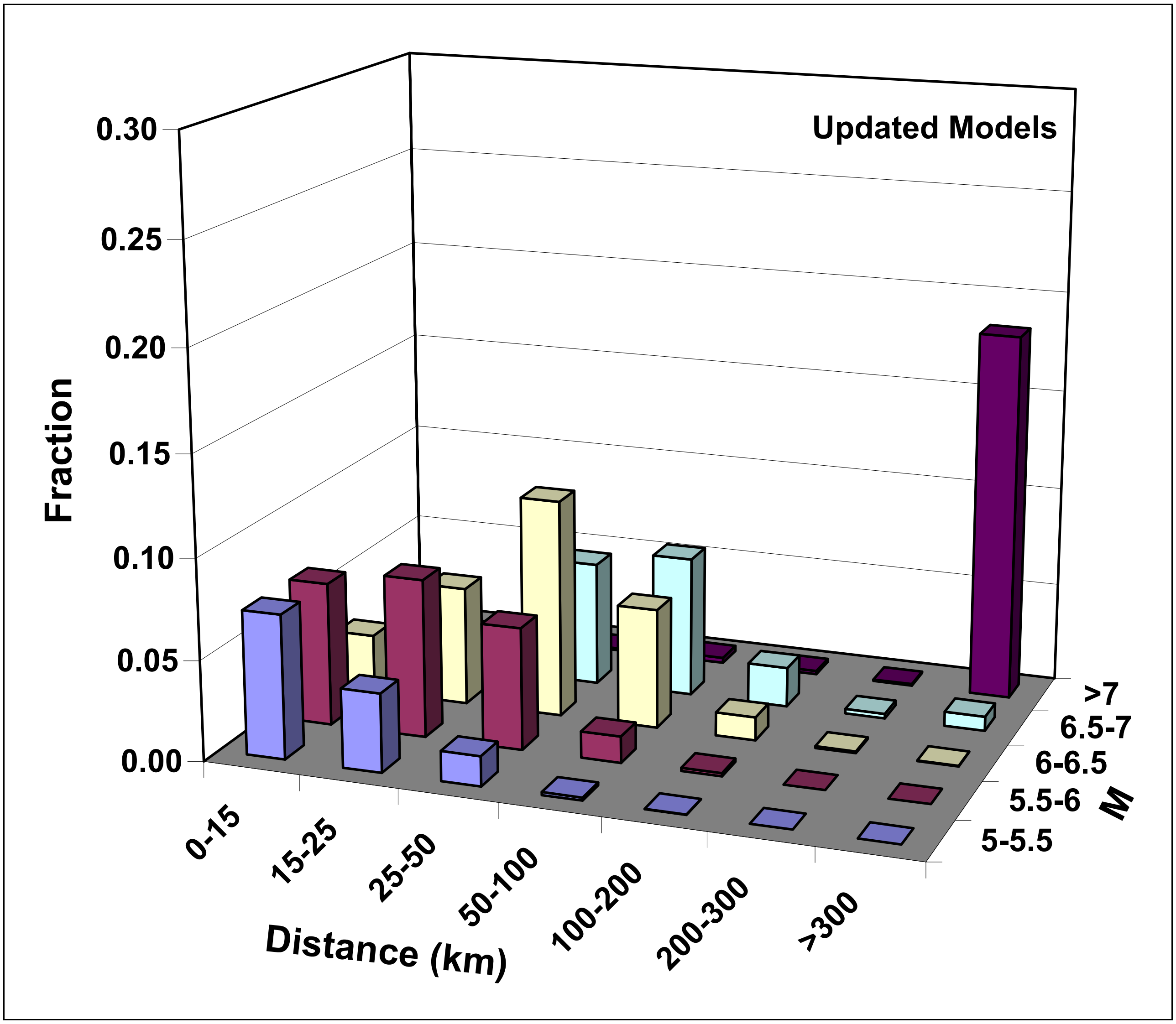


Figure 2.5-49 Magnitude-Distance Deaggregation for Low-Frequencies (1 and 2.5 Hz) at a Mean Annual Frequency of 5×10^{-5} Using Updated Source and Ground Motion Models

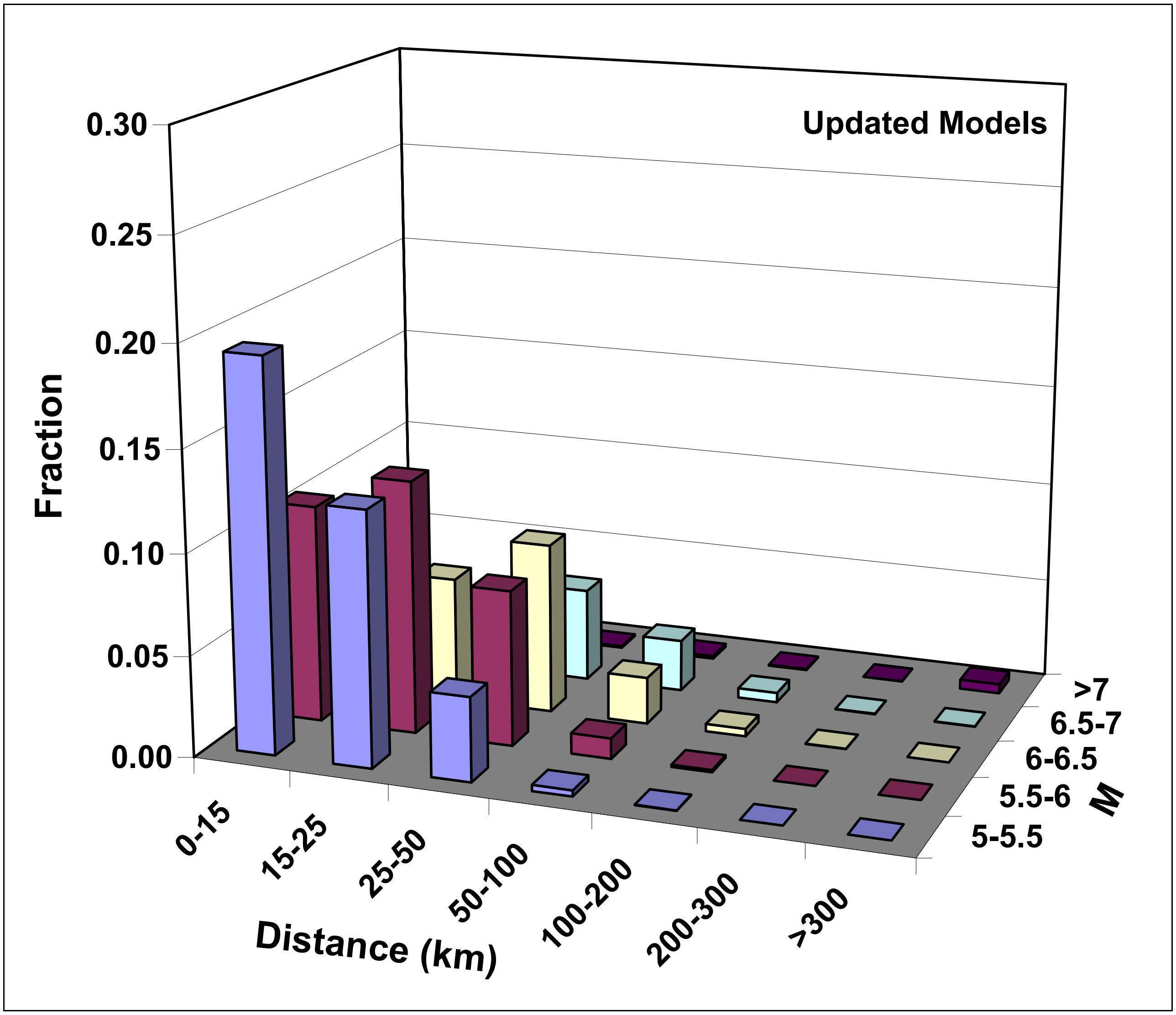


Figure 2.5-50 Magnitude-Distance Deaggregation for High-Frequencies (5 and 10 Hz) at a Mean Annual Frequency of 5×10^{-5} Using Updated Source and Ground Motion Models

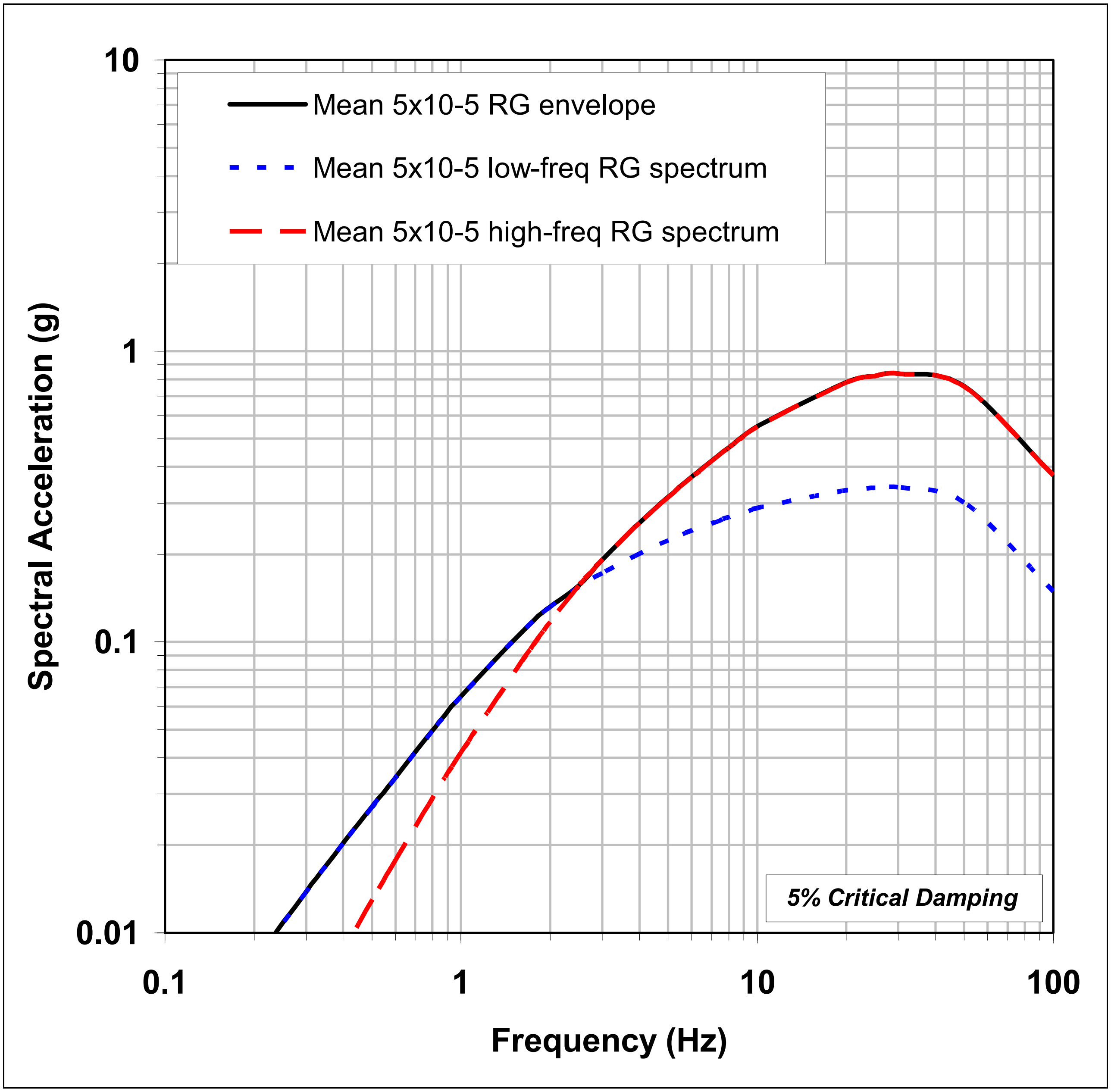


Figure 2.5-51 Low-Frequency, High-Frequency, and Envelope Horizontal Hard Rock SSE Spectra for RG 1.165 Reference Probability Approach Using 5×10^{-5}

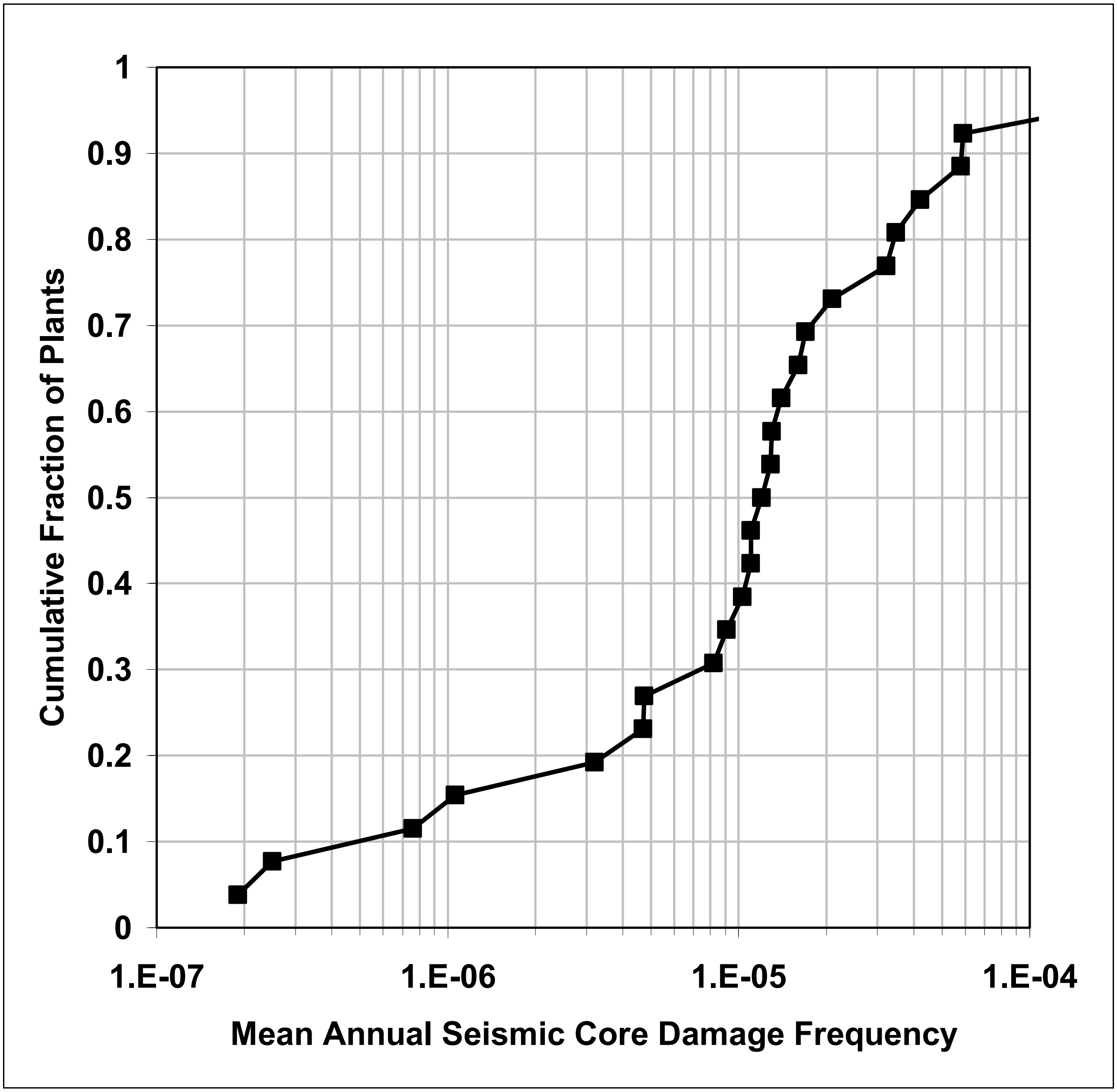


Figure 2.5-52 Cumulative Distribution of Seismic Core Damage Frequency (SCDF) for 25 Existing U.S. Nuclear Plants as Reported in NUREG-1742 (Reference 196)

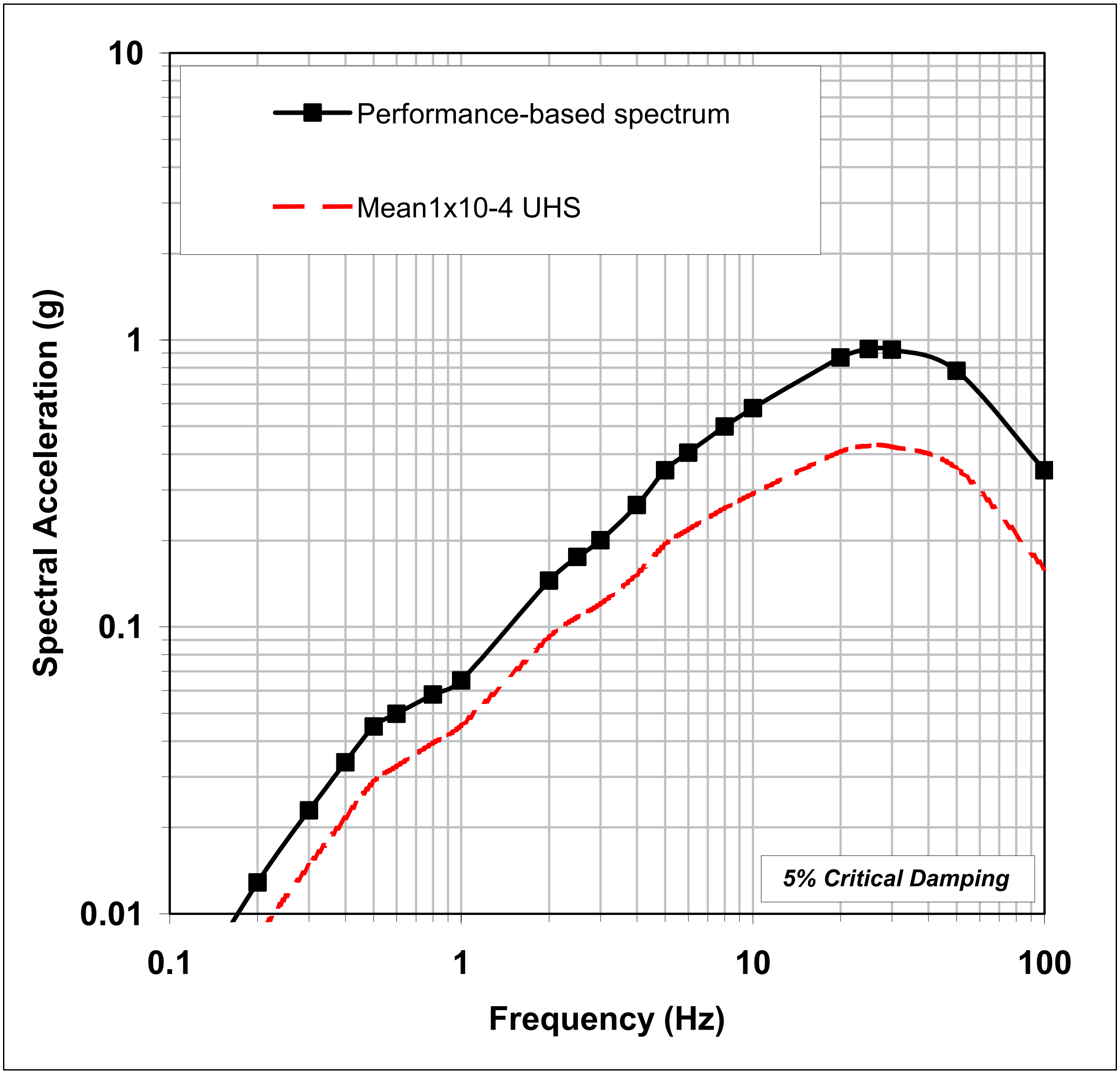


Figure 2.5-53 Performance-Based Horizontal Hard Rock SSE Spectrum, and Mean 10^{-4} Horizontal Uniform Hazard Spectrum

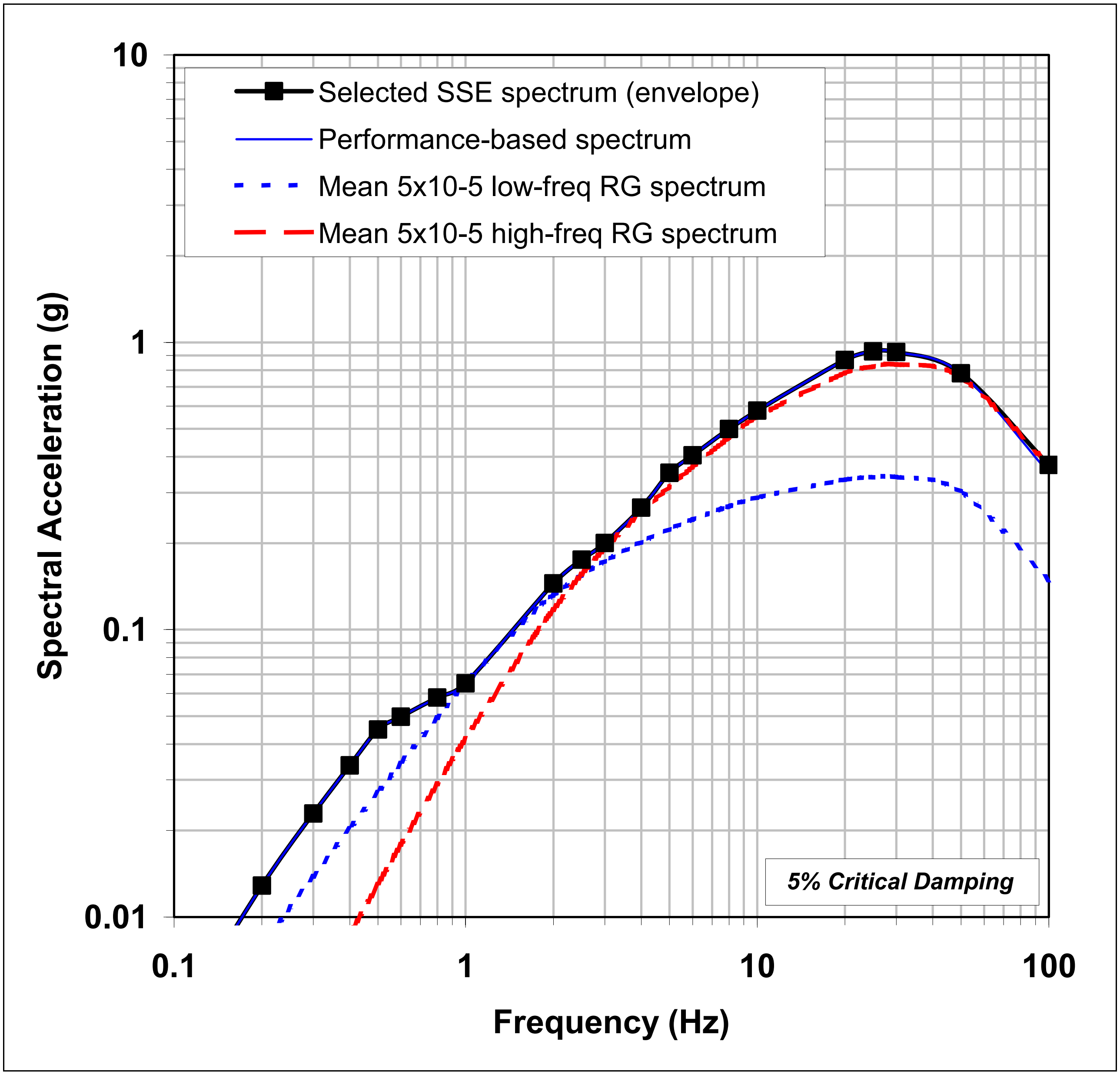


Figure 2.5-54A Comparison of Performance-Based Spectrum, Mean 5 $\times$ 10^{-5} Scaled Spectra, and Selected Hard Rock SSE Spectrum (Which Envelops the Other Three)

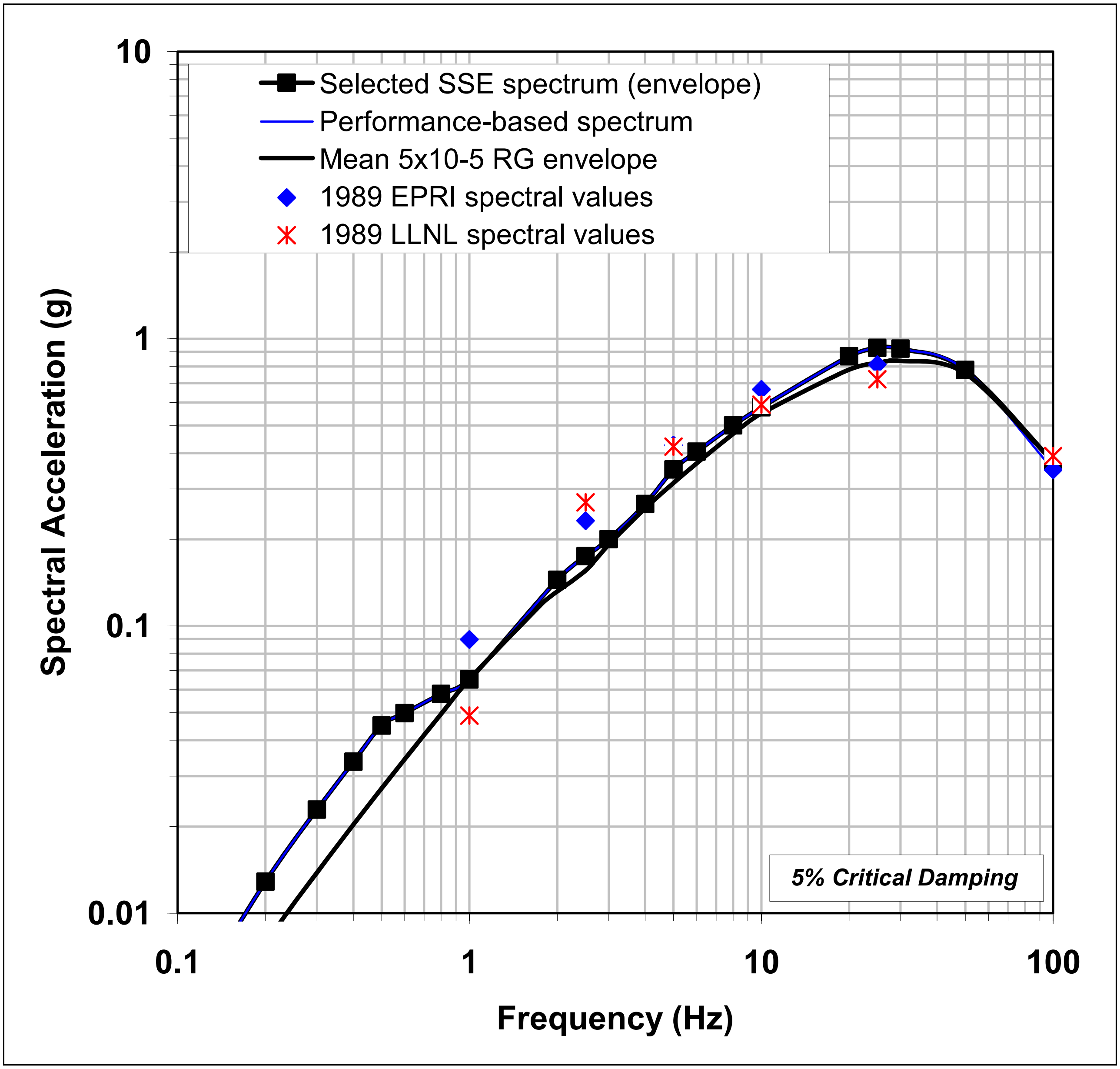


Figure 2.5-54B Comparison of Mean 5×10^{-5} RG 1.165 Envelope, 1989 EPRI (Reference 115), 1989 LLNL (Extrapolated from Reference 129), and Selected Hard Rock SSE Spectra

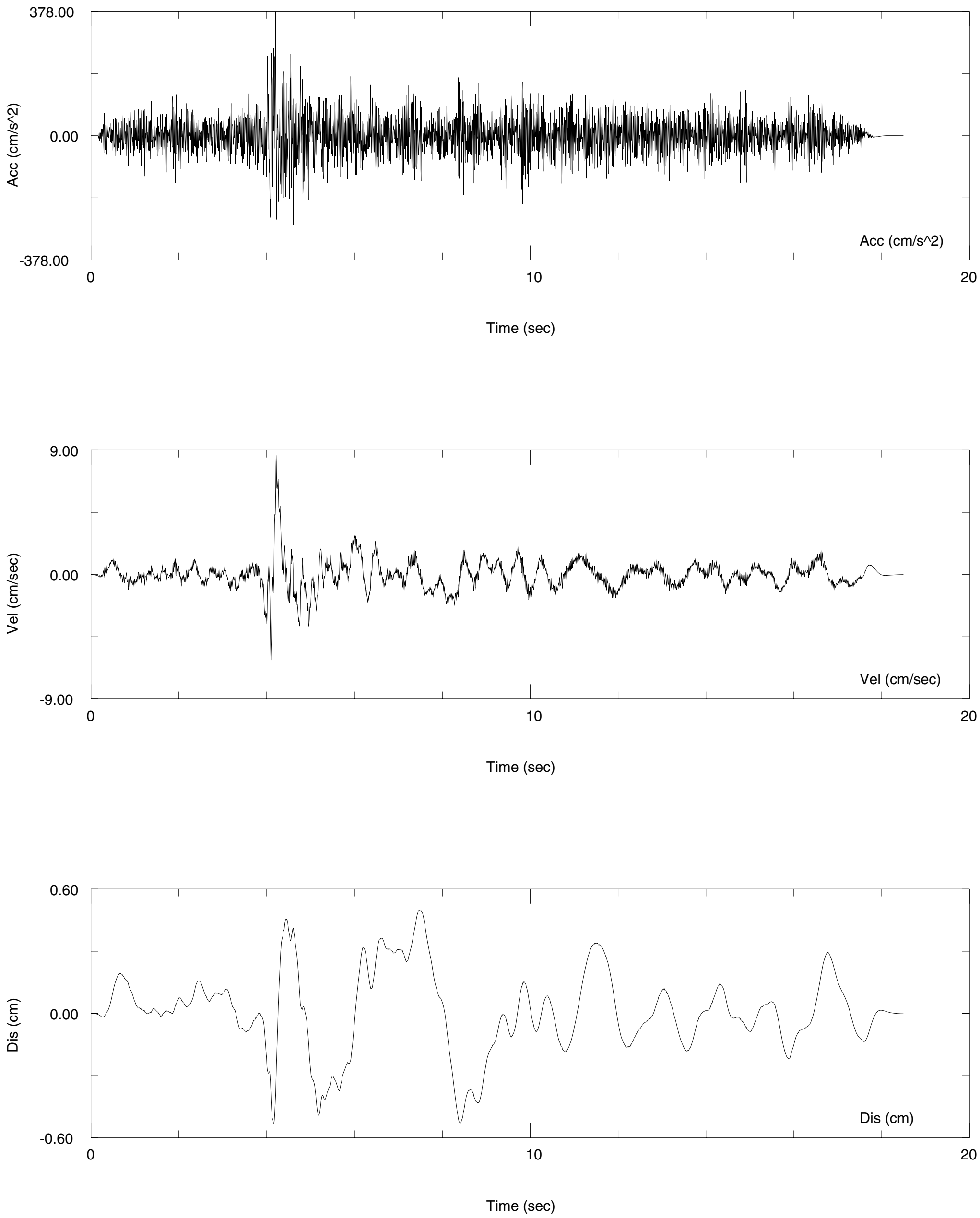


Figure 2.5-54B(1) Time History Developed To Be Spectrum-Compatible with the High-Frequency Target Spectrum for the Hard Rock SSE

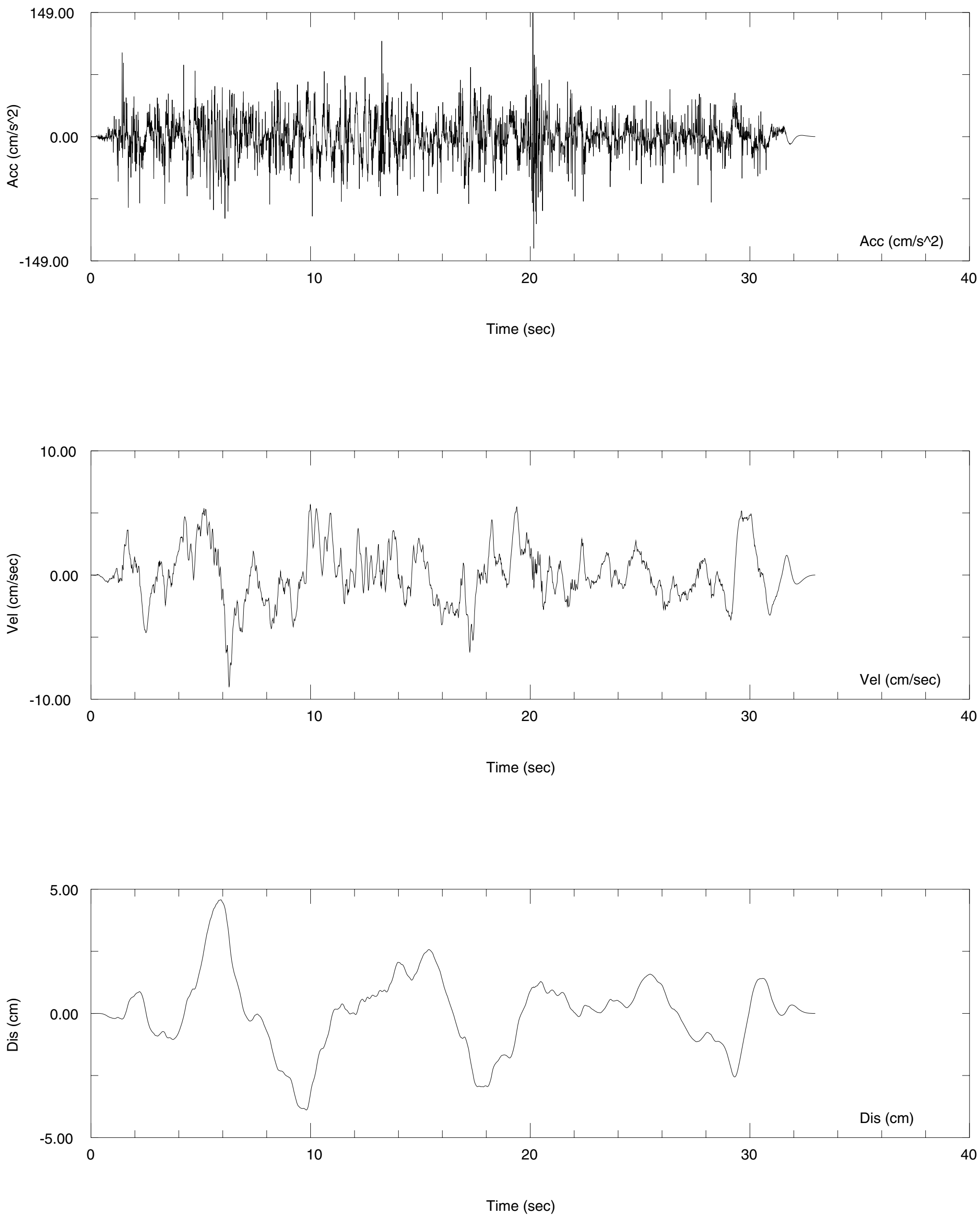


Figure 2.5-54B(2) Time History Developed To Be Spectrum-Compatible with the Low-Frequency Target Spectrum for the Hard Rock SSE

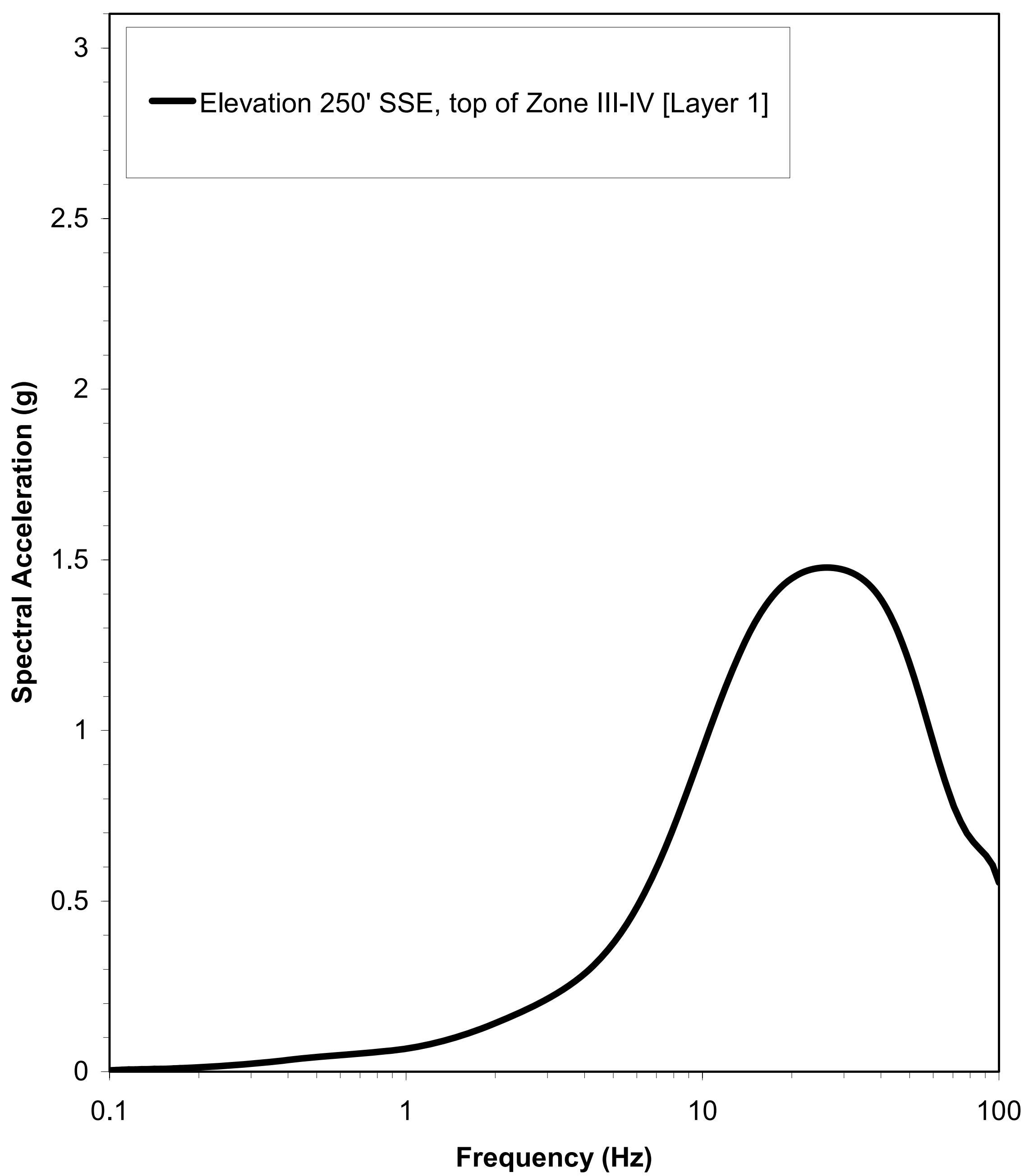


Figure 2.5-54B(3) Smooth Fitting Function Through the SHAKE Analysis Response Spectrum Results for the Hypothetical Rock Outcrop Control Point at the Top of Zone III-IV Material (Representative Elevation 250 ft, 3300 ft/sec Shear Wave Velocity)

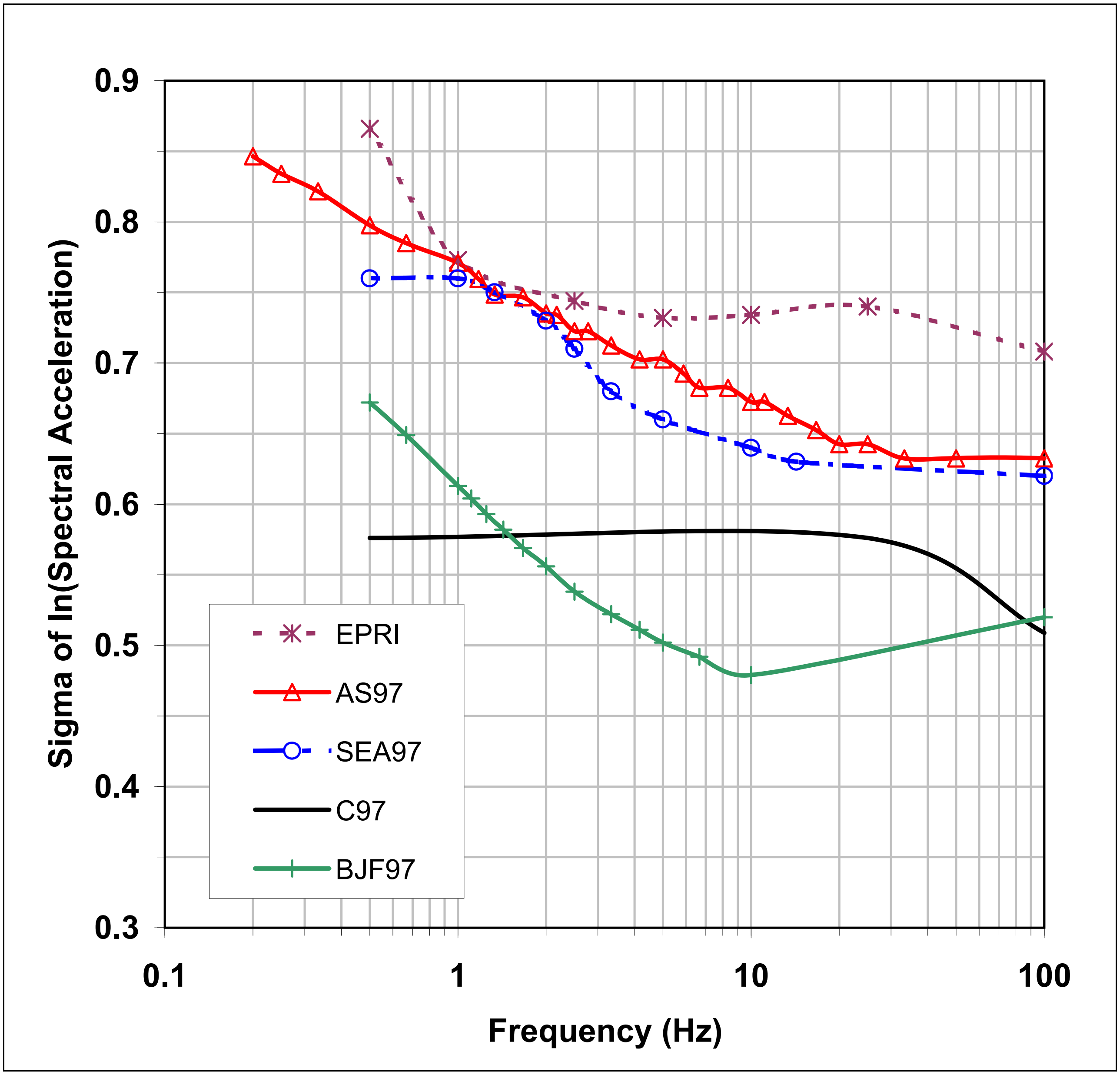


Figure 2.5-54C Comparison of Aleatory Sigmas Reported for California with Weighted Average Aleatory Sigma from EPRI Ground Motion 2003 Models for M = 5.5, R_{CD} = 20 km

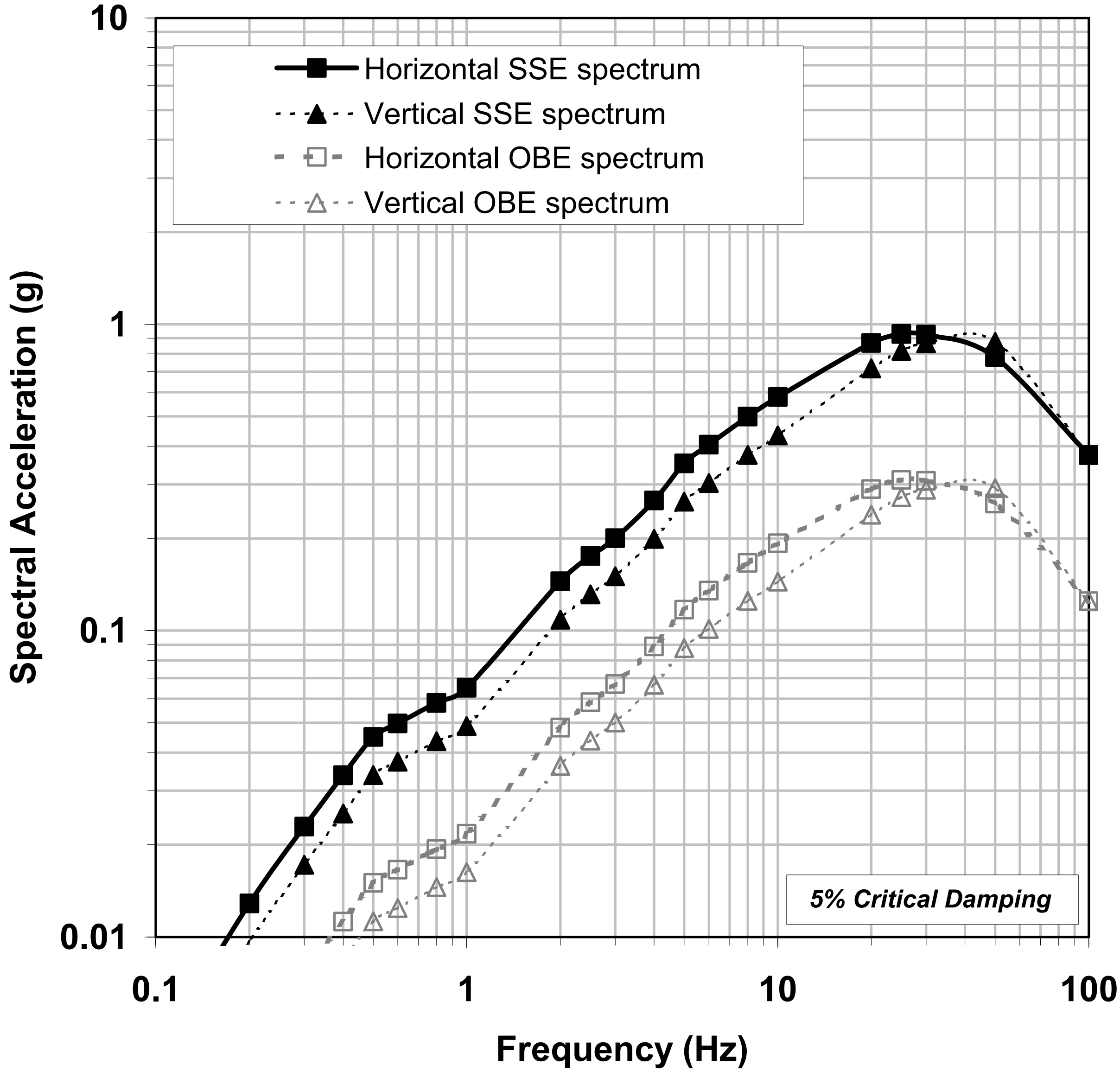


Figure 2.5-55 Selected Horizontal and Vertical SSE and OBE Spectra Based on Updated Models (5% Critical Damping)

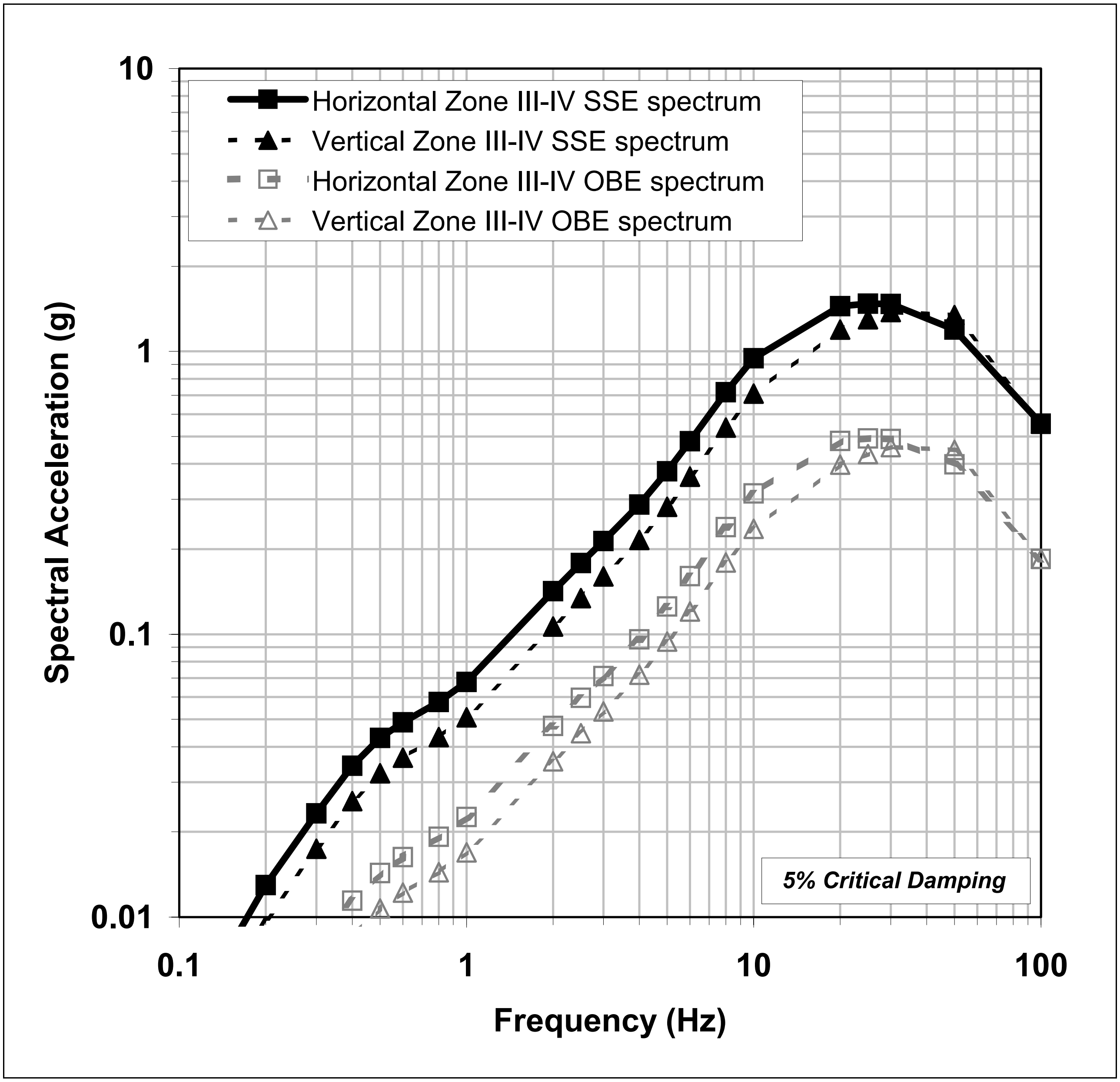


Figure 2.5-55A Selected Horizontal and Vertical OBE and SSE Spectra for the Hypothetical Rock Outcrop Control Point at the Top of Zone III-IV Material (Representative Elevation 250 ft, 3300 ft/sec Shear Wave Velocity)

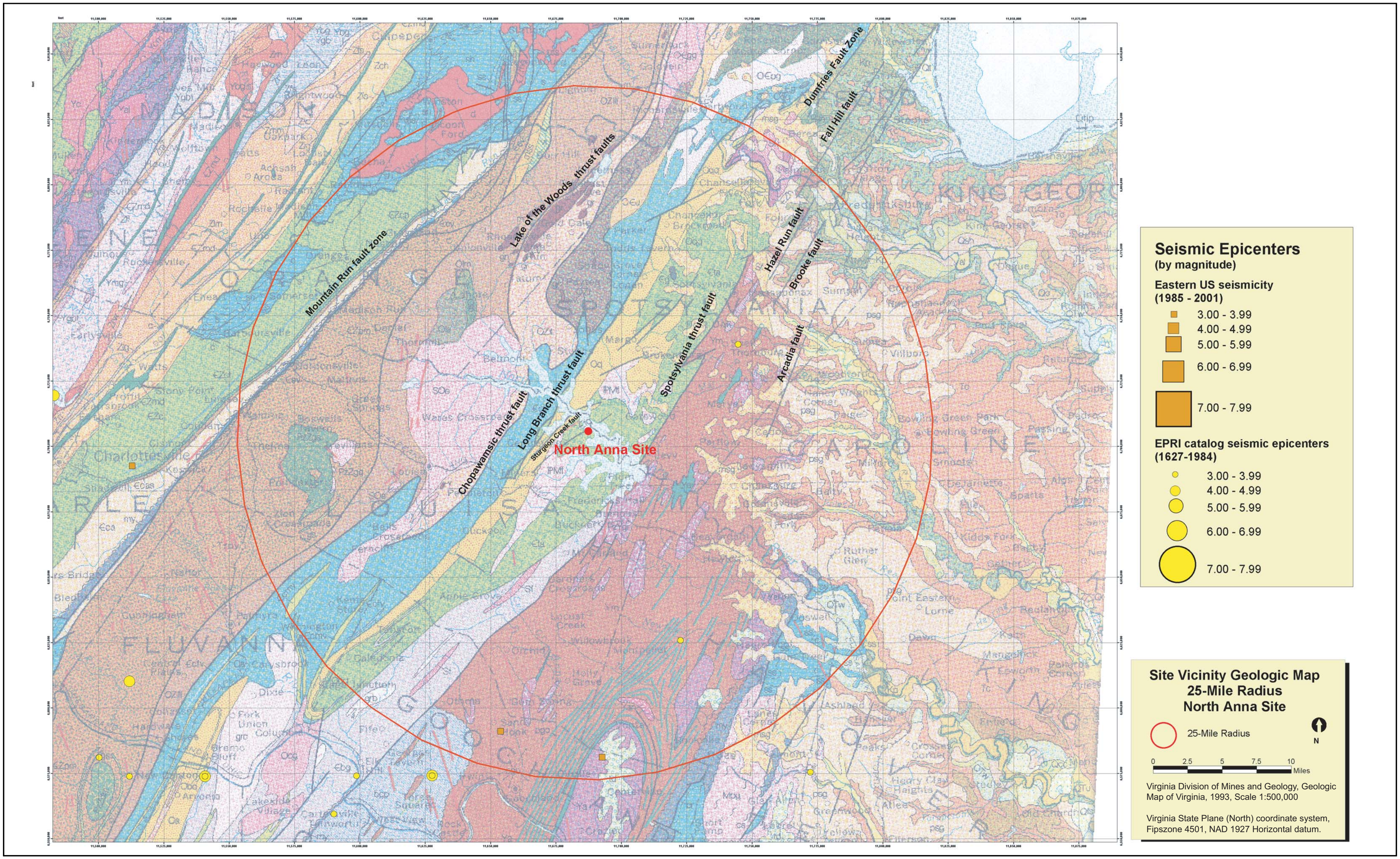


Figure 2.5-56 Site Vicinity Geologic Map and Seismicity (25-Mile Radius)

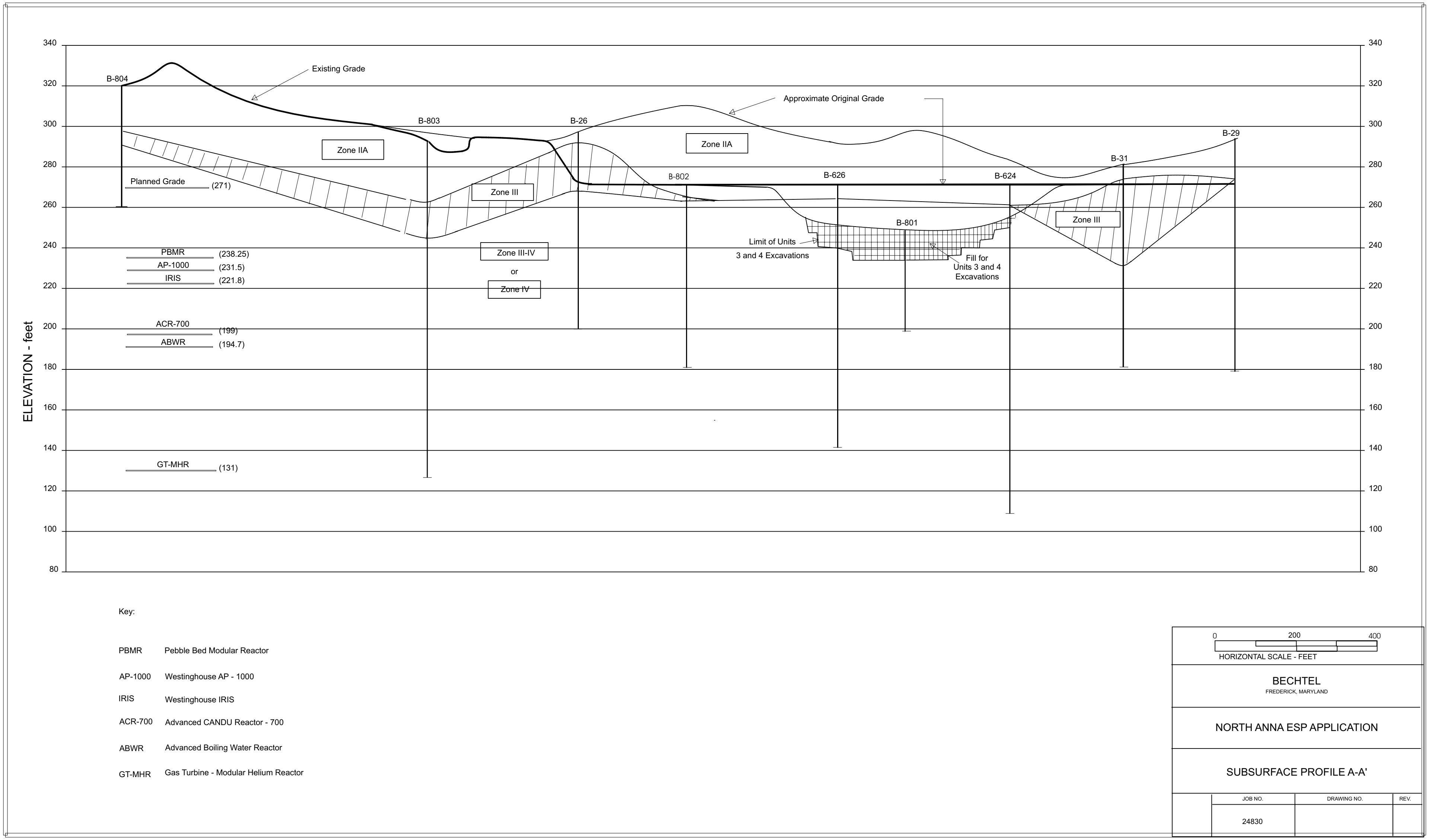


Figure 2.5-57 Subsurface Profile A-A'

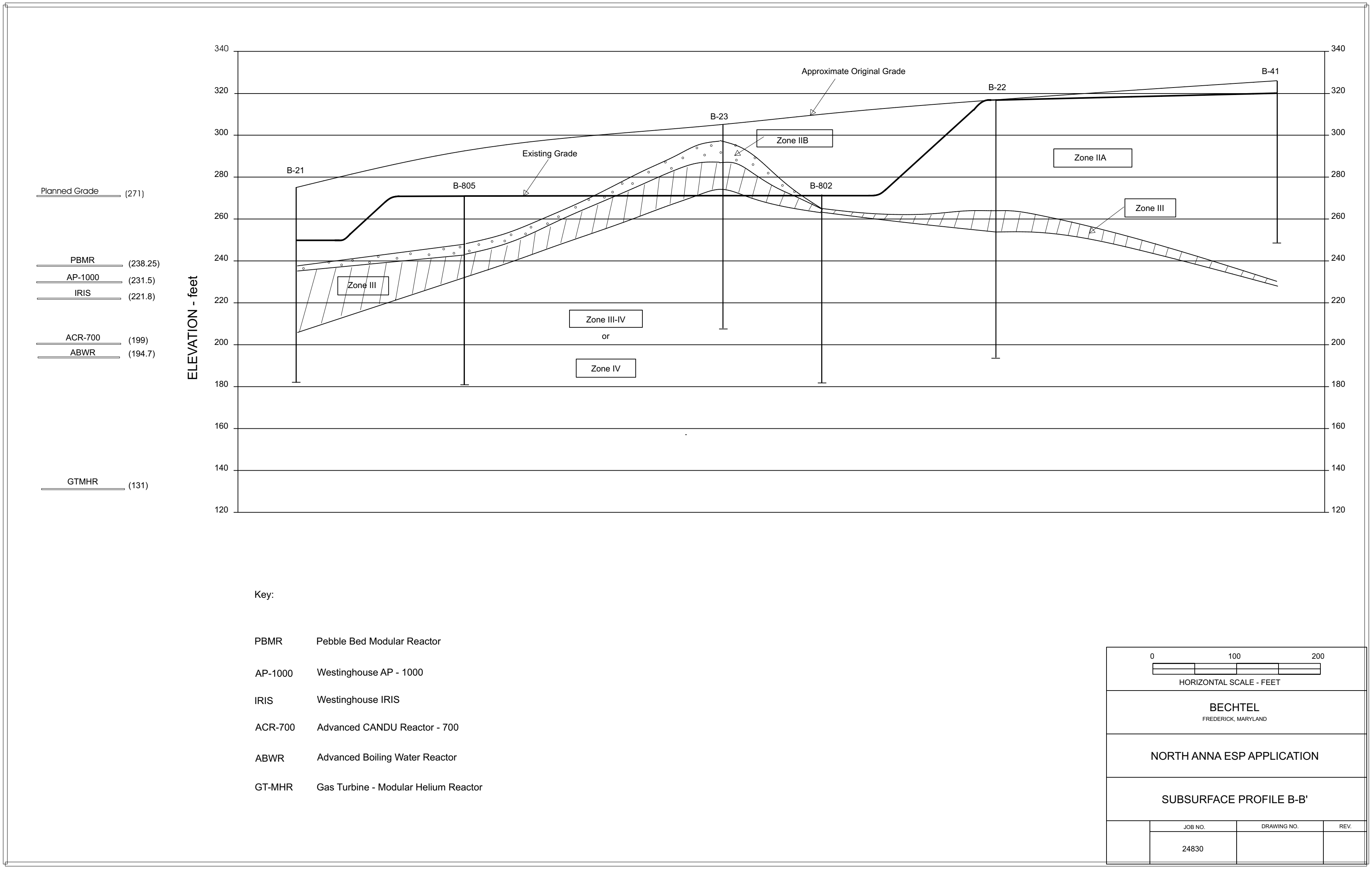


Figure 2.5-58 Subsurface Profile B-B'

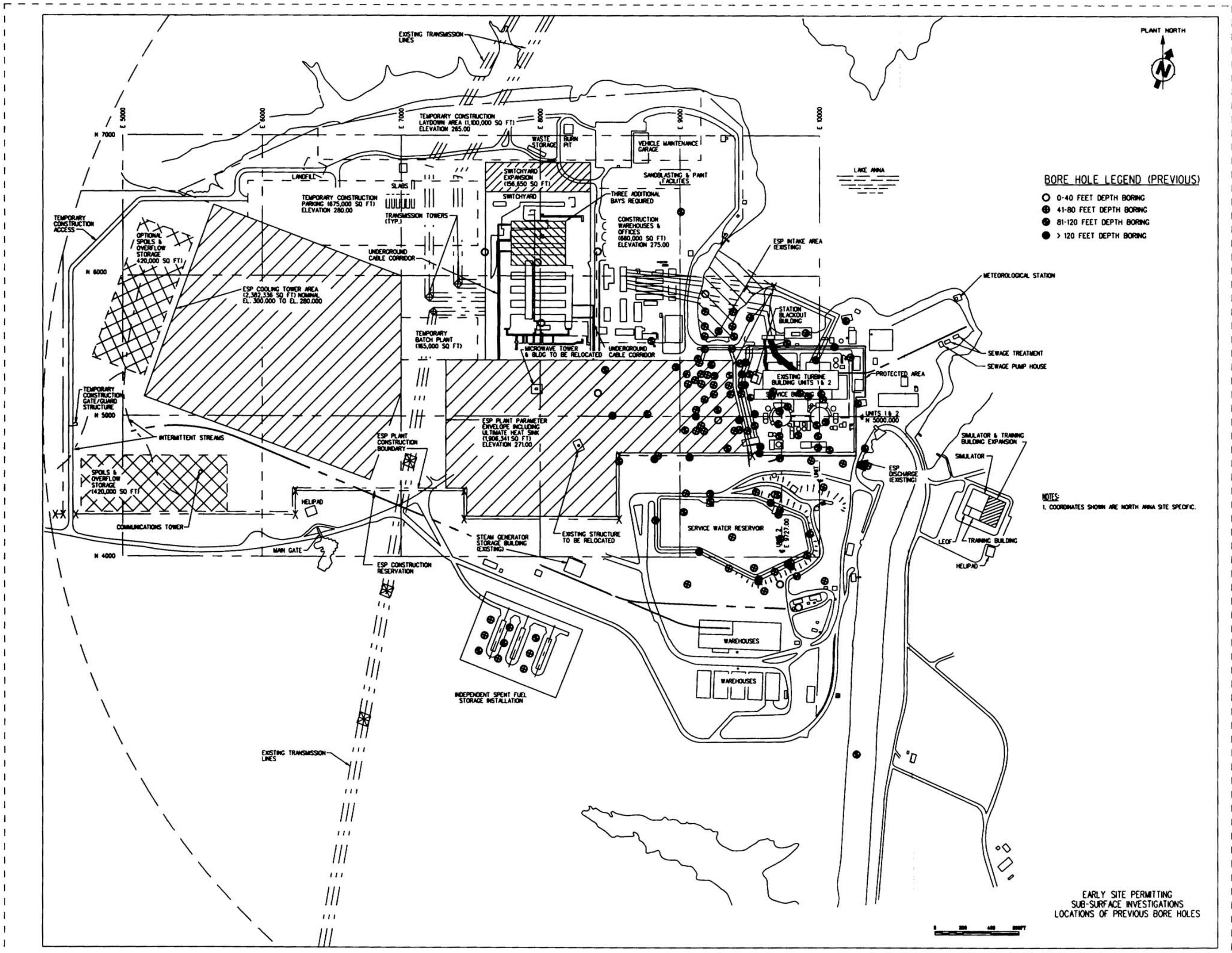


Figure 2.5-59 Locations of Previous Boreholes

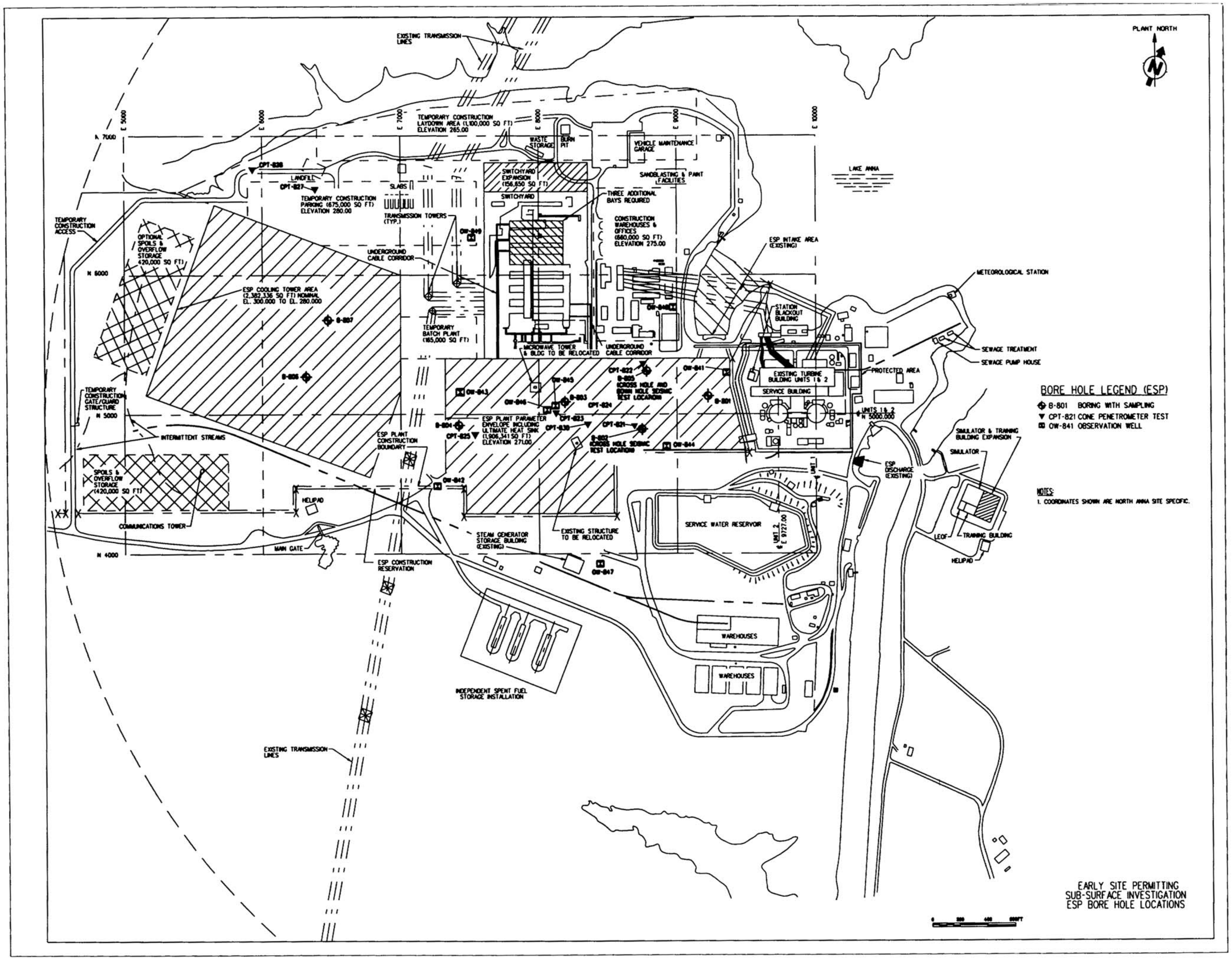


Figure 2.5-60 ESP Borehole Locations

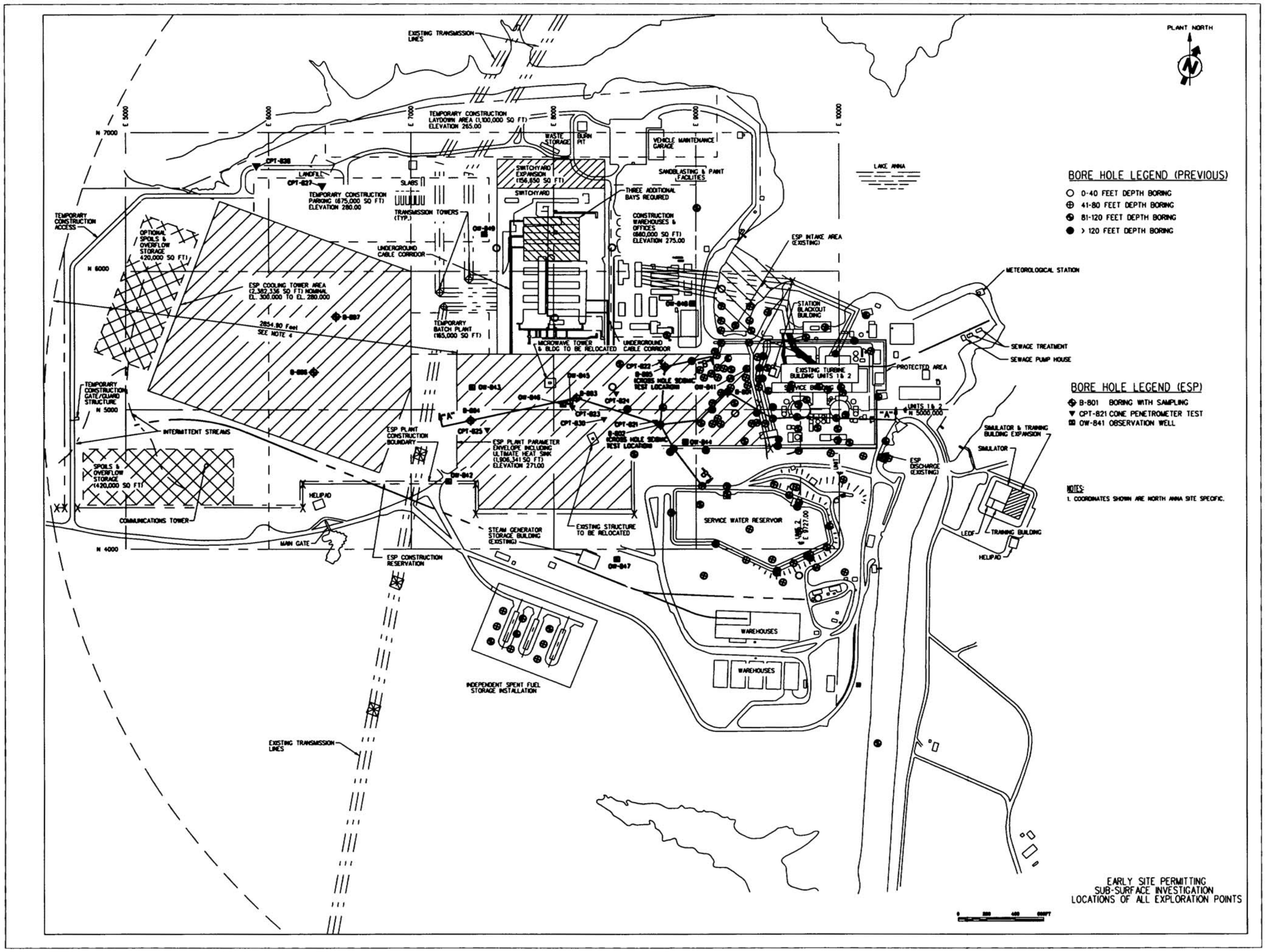


Figure 2.5-61 Locations of All Exploration Points

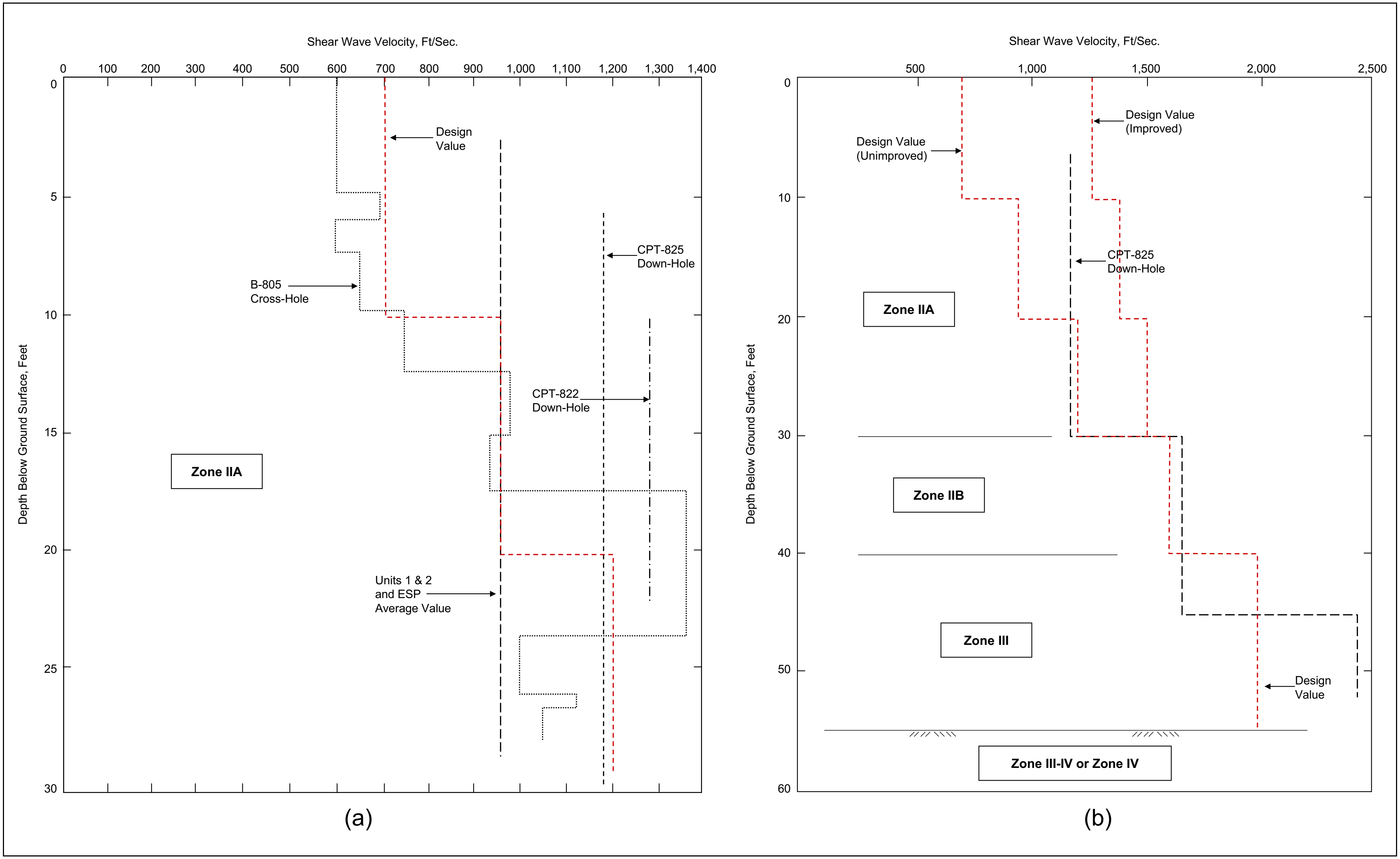


Figure 2.5-62 Zone IIA Shear Wave Velocity Profile (a) Full-Depth Shear Wave Velocity Profile (b)

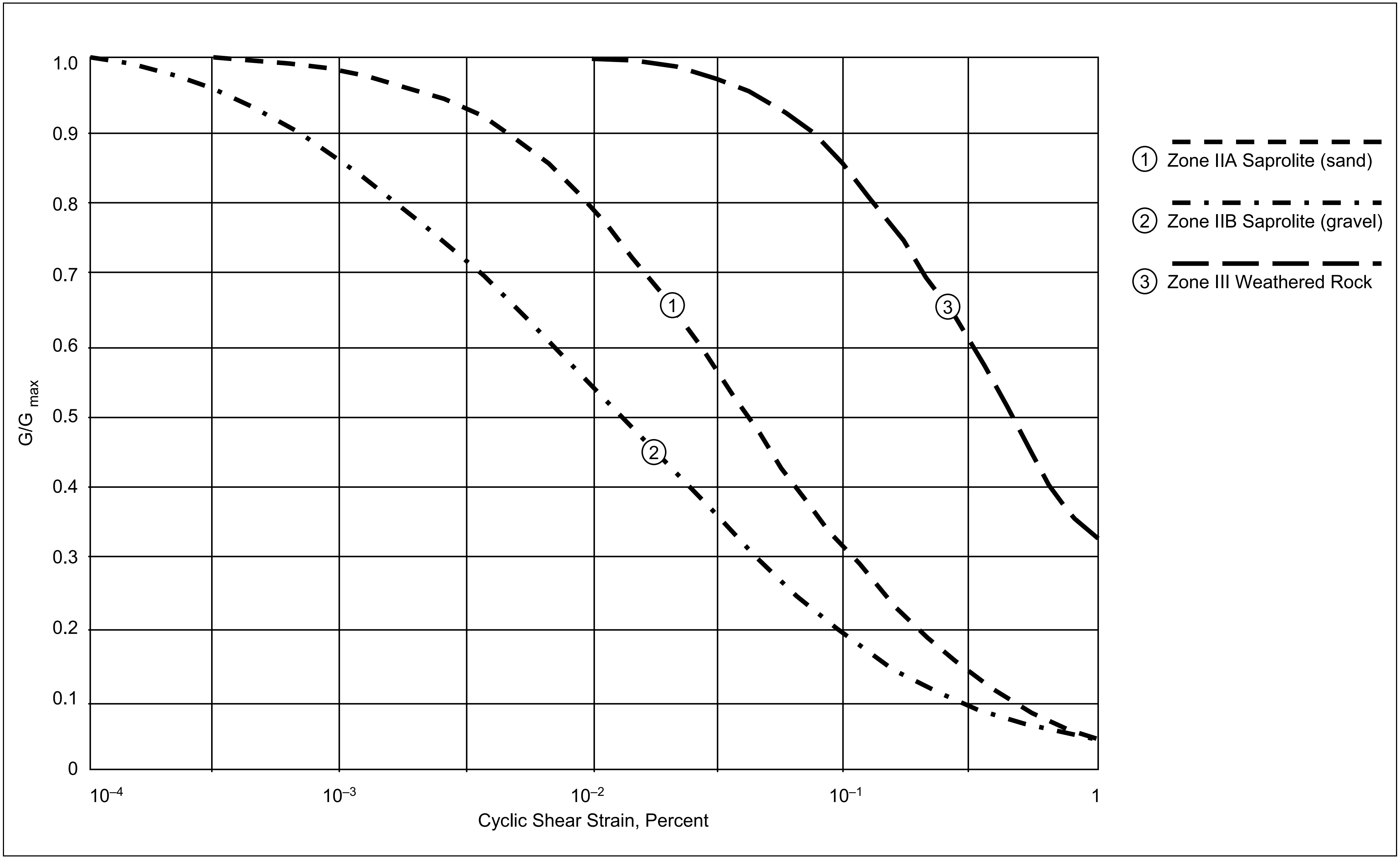


Figure 2.5-63 Variation of Normalized Shear Modulus with Cycle Shear Strain

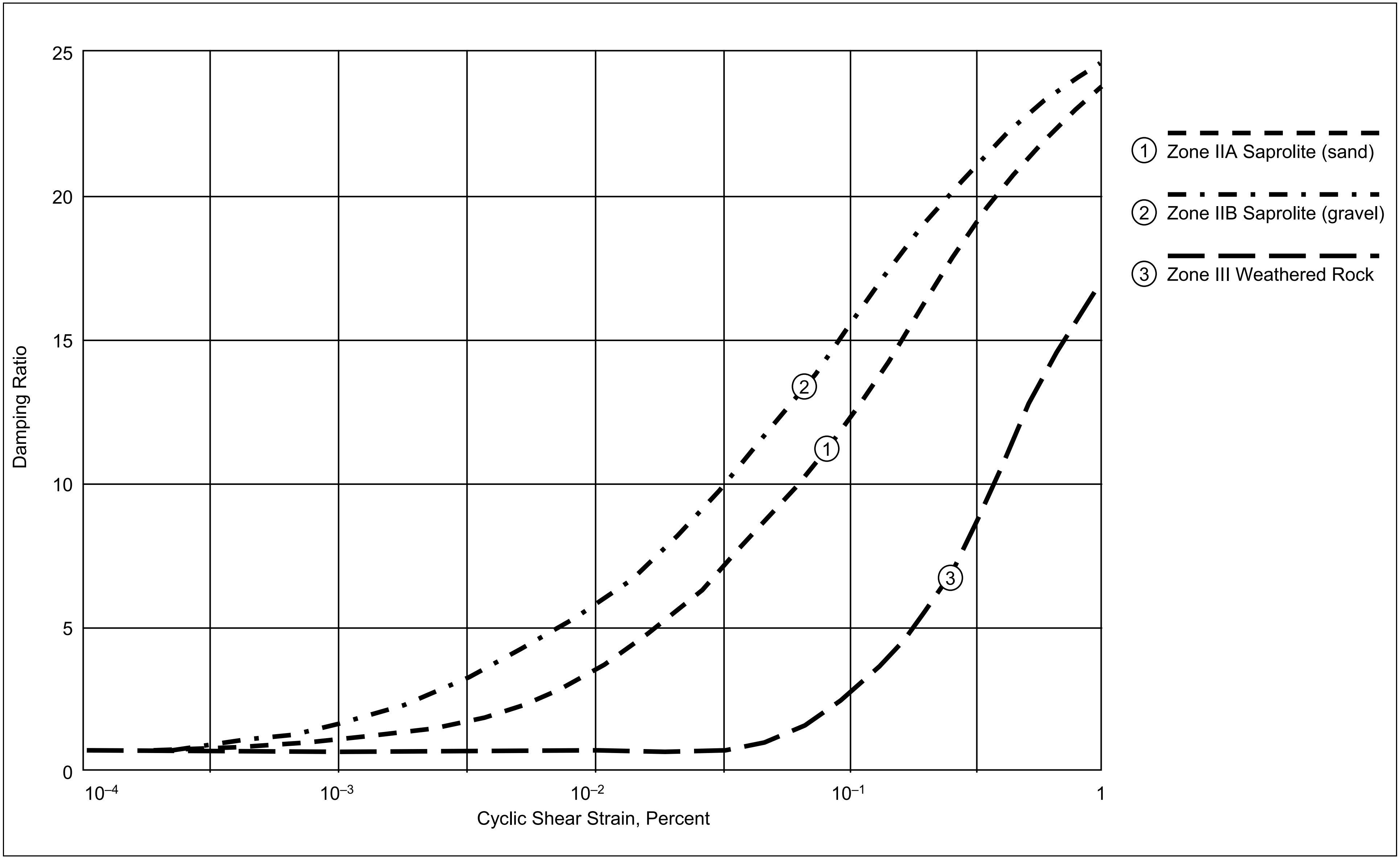


Figure 2.5-64 Variation of Damping Ratio with Cyclic Shear Strain

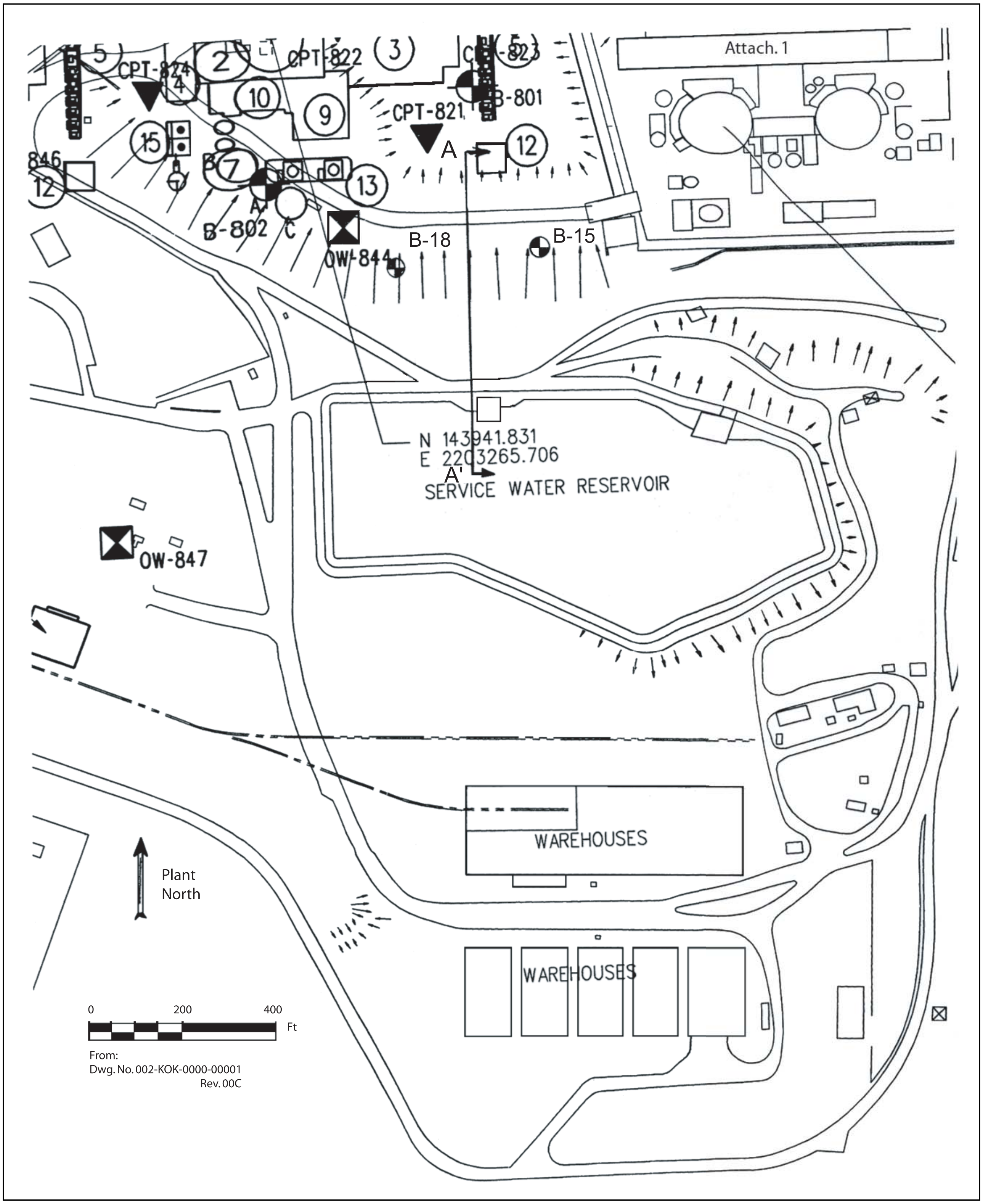


Figure 2.5-65 Plan View of Slope North of the SWR

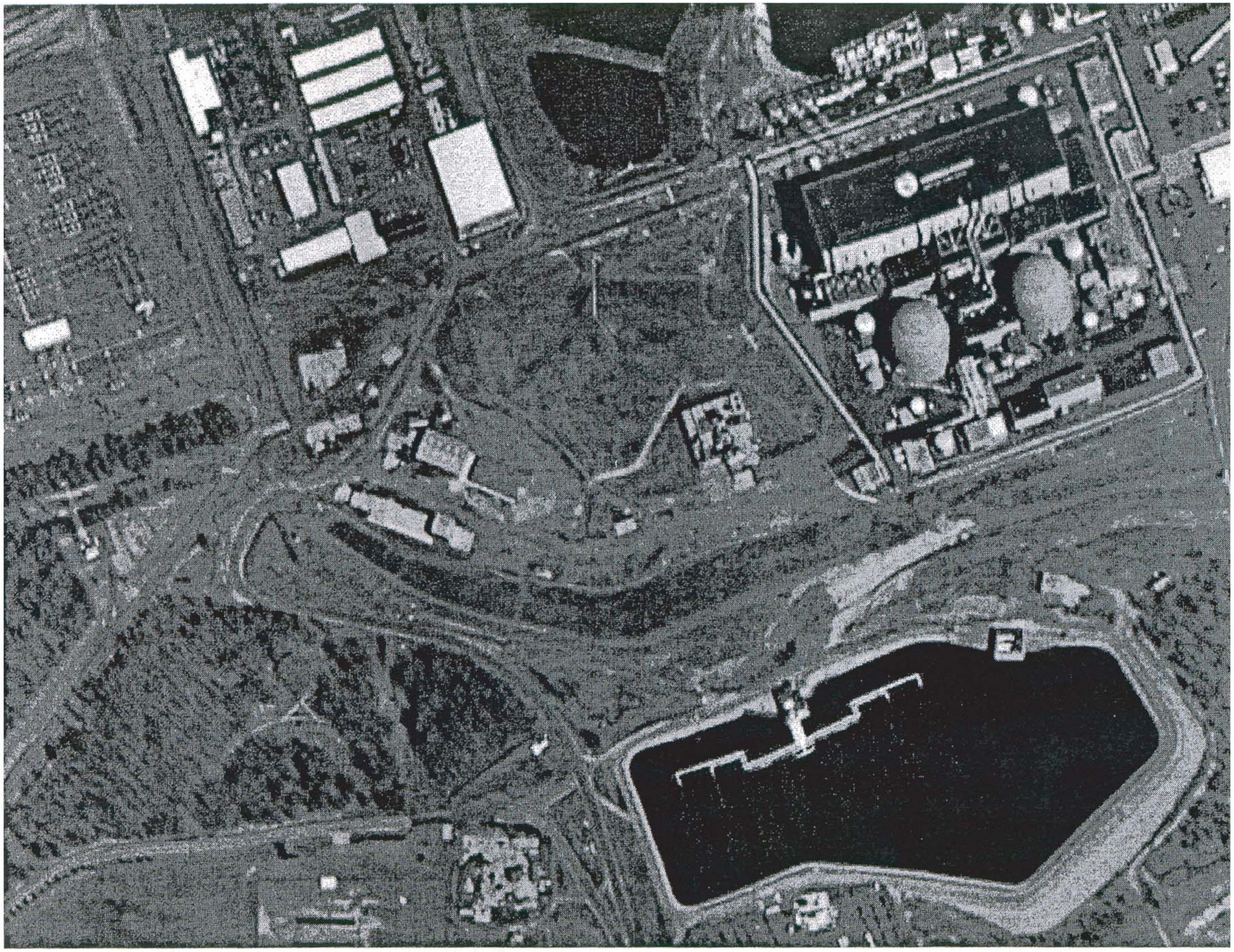


Figure 2.5-66 Photograph of Plan View of Slope North of the SWR

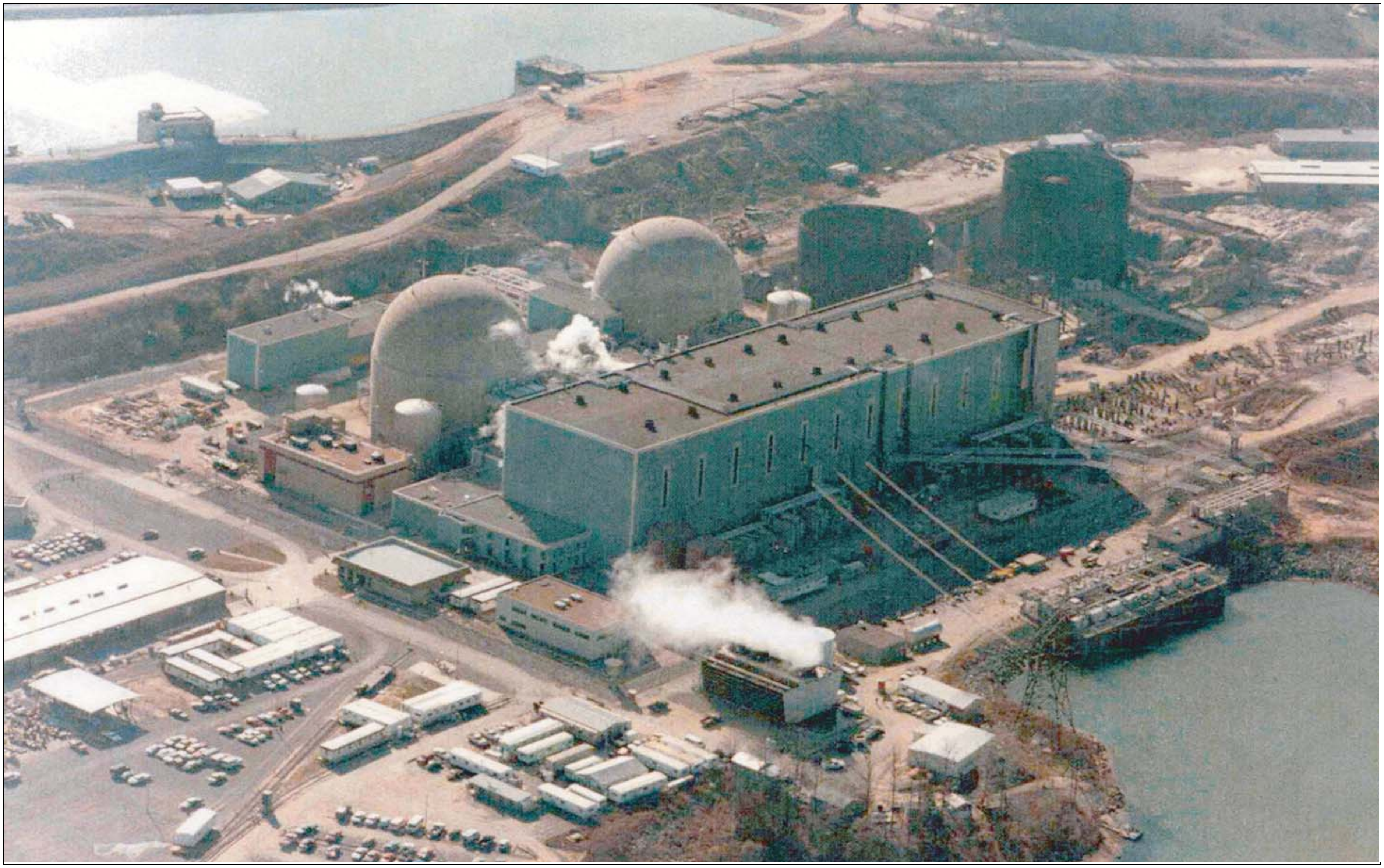


Figure 2.5-67 Photograph of Slope North of the SWR

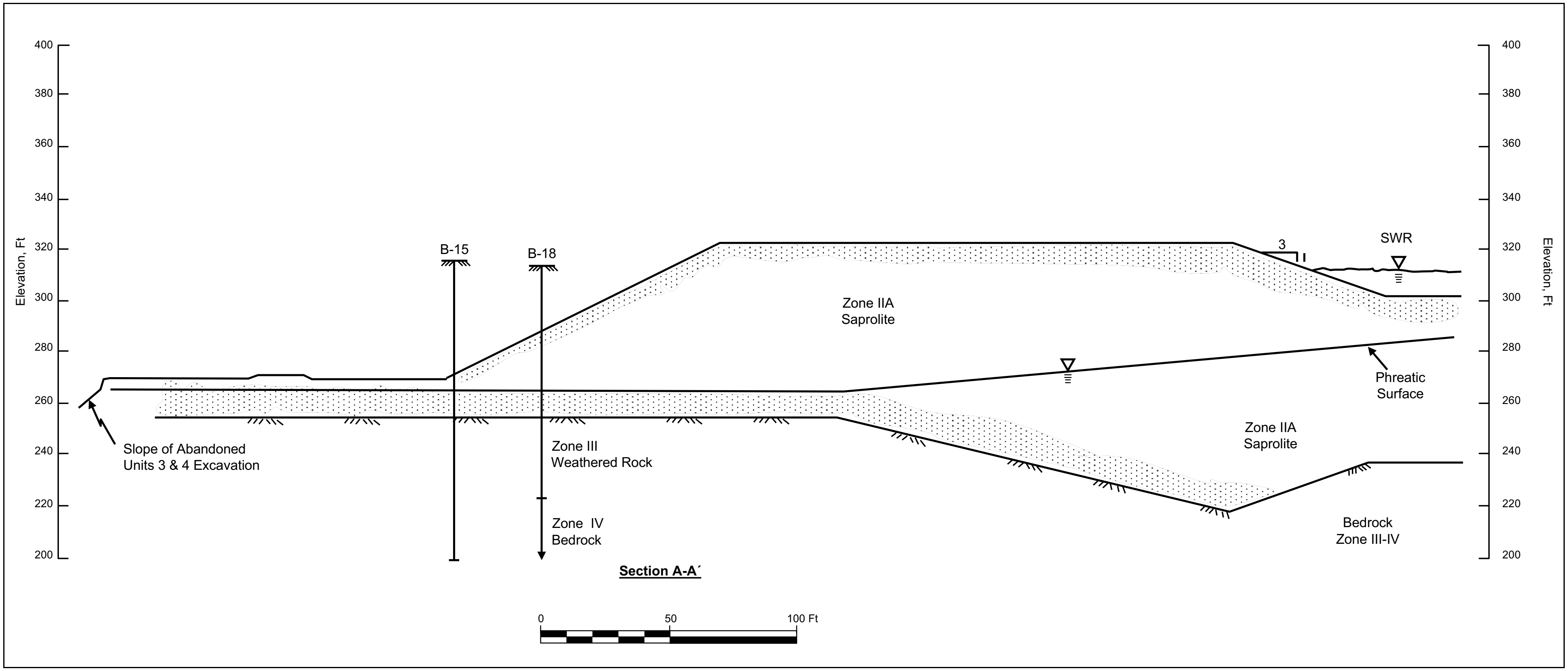


Figure 2.5-68 Cross-Section of Existing Slope North of the SWR

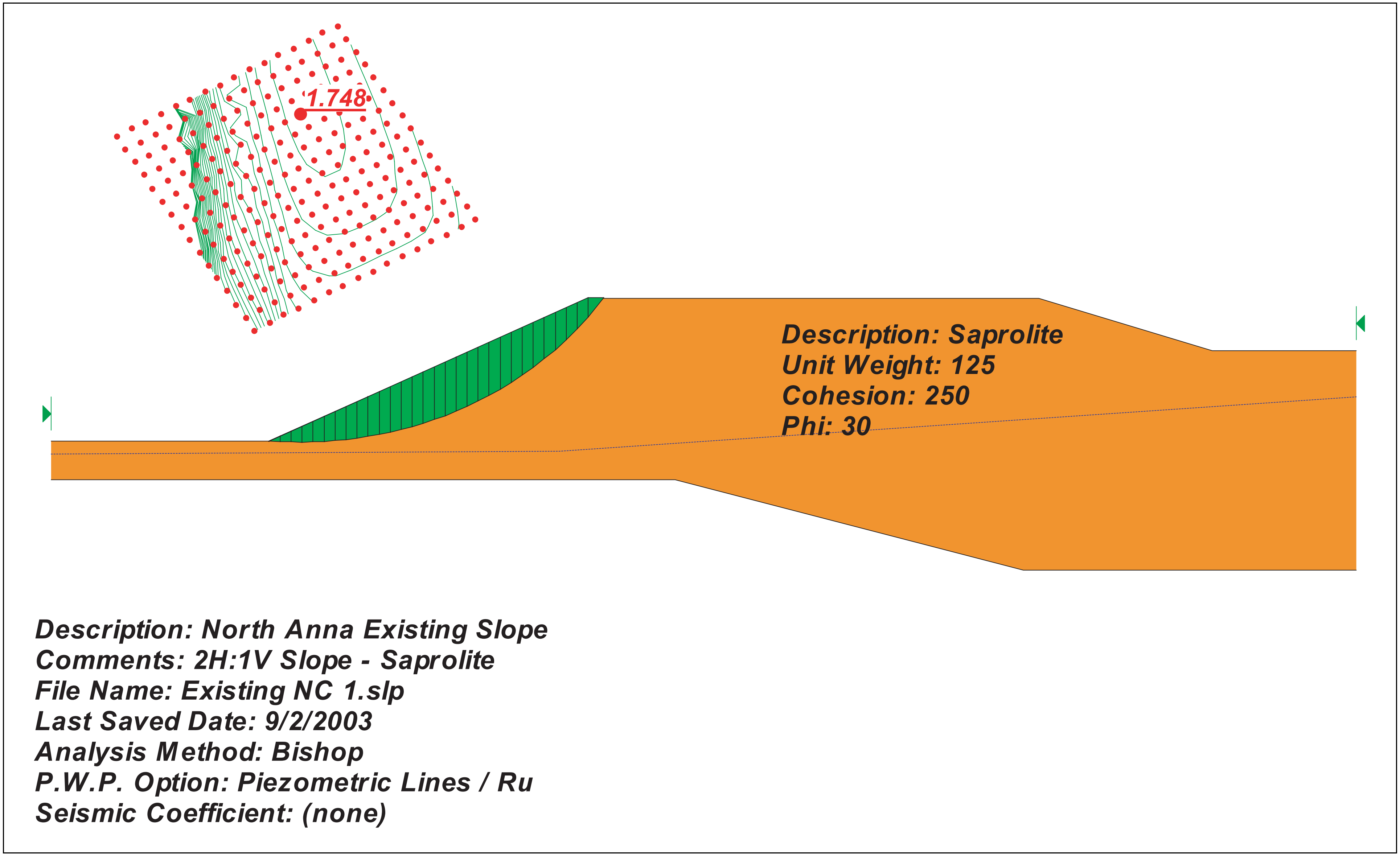


Figure 2.5-69 SLOPE/W Analysis of Long-Term Static Case

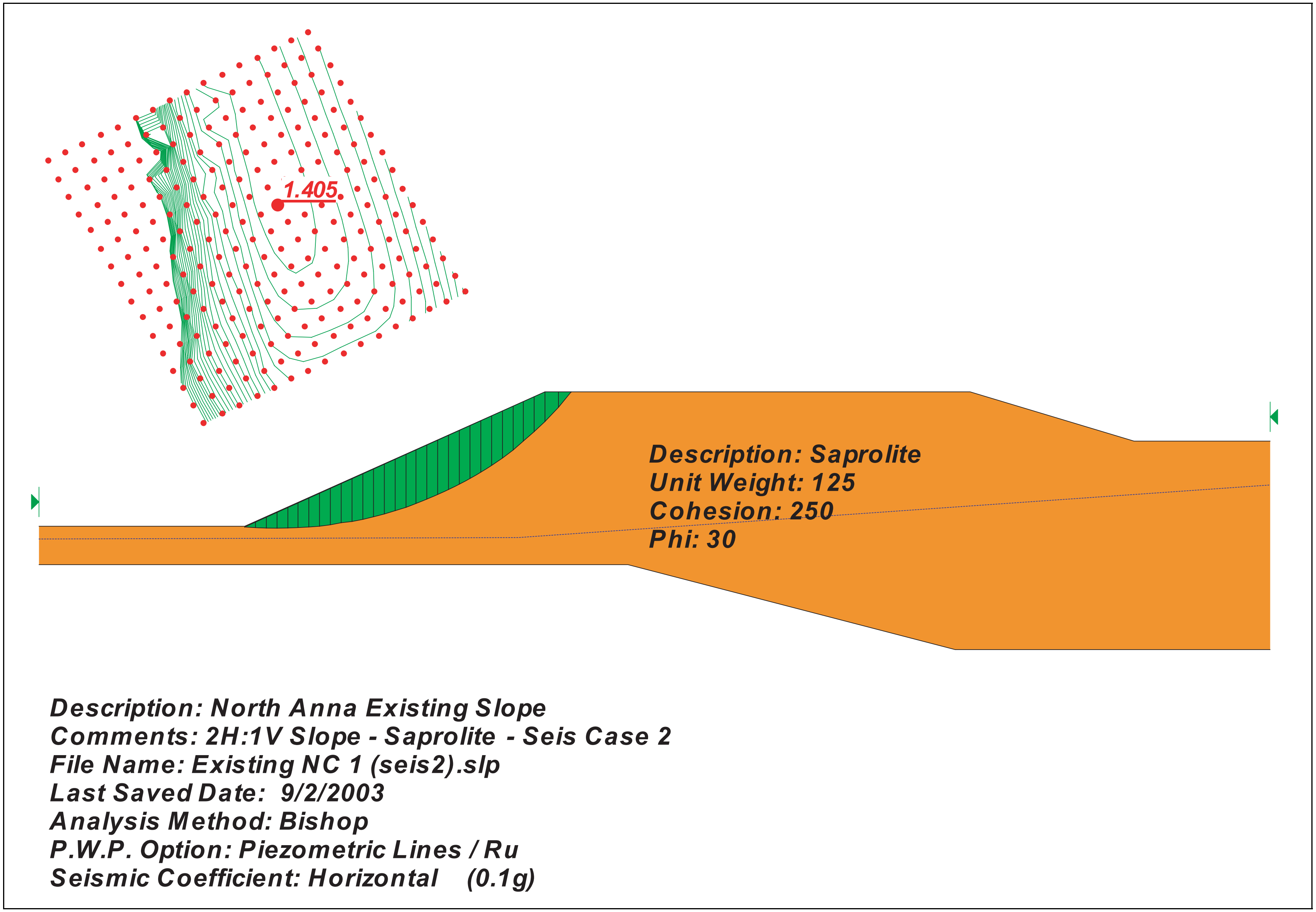


Figure 2.5-70 SLOPE/W Analysis of Seismic Case

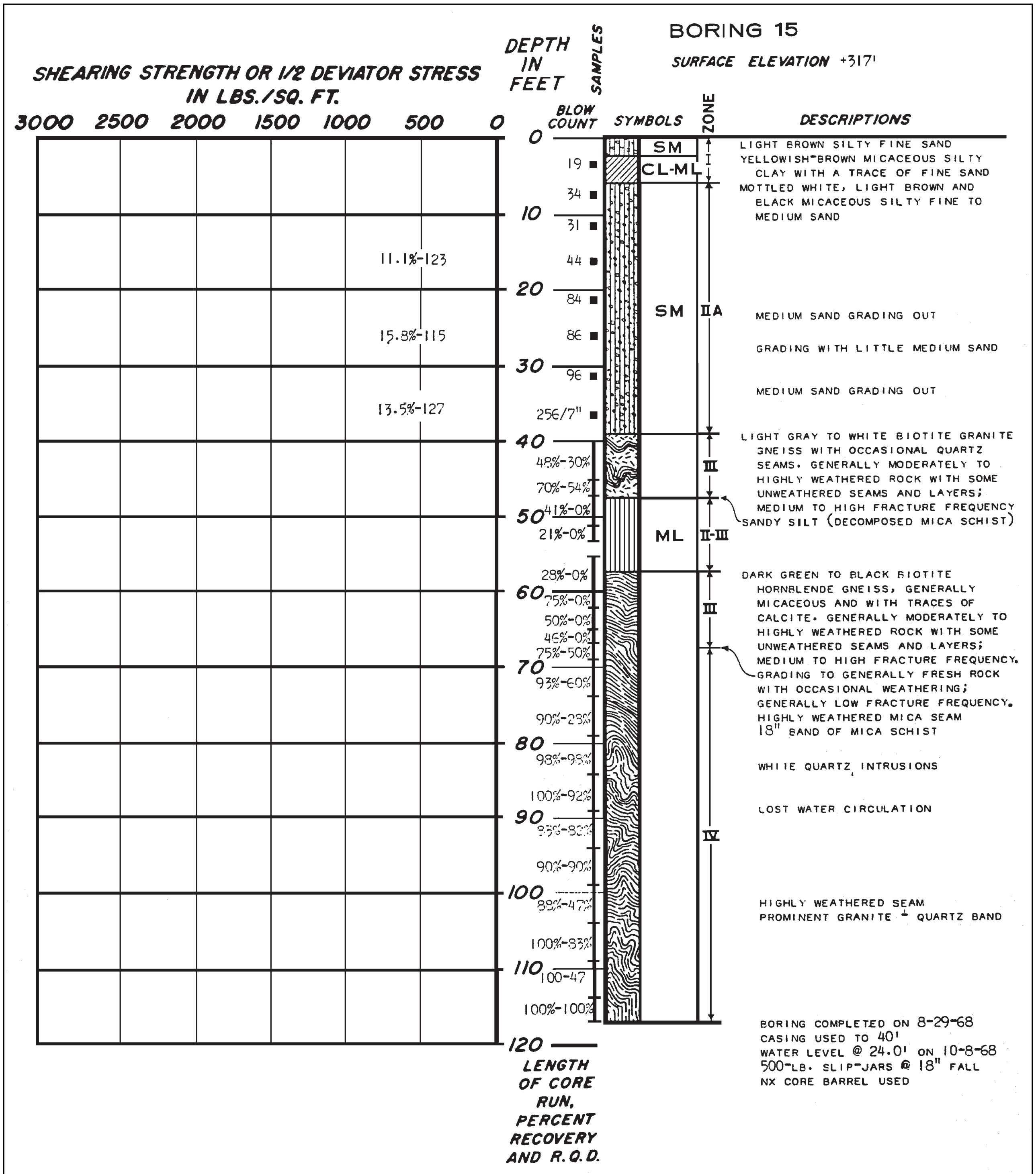


Figure 2.5-71 Log of Boring B-15

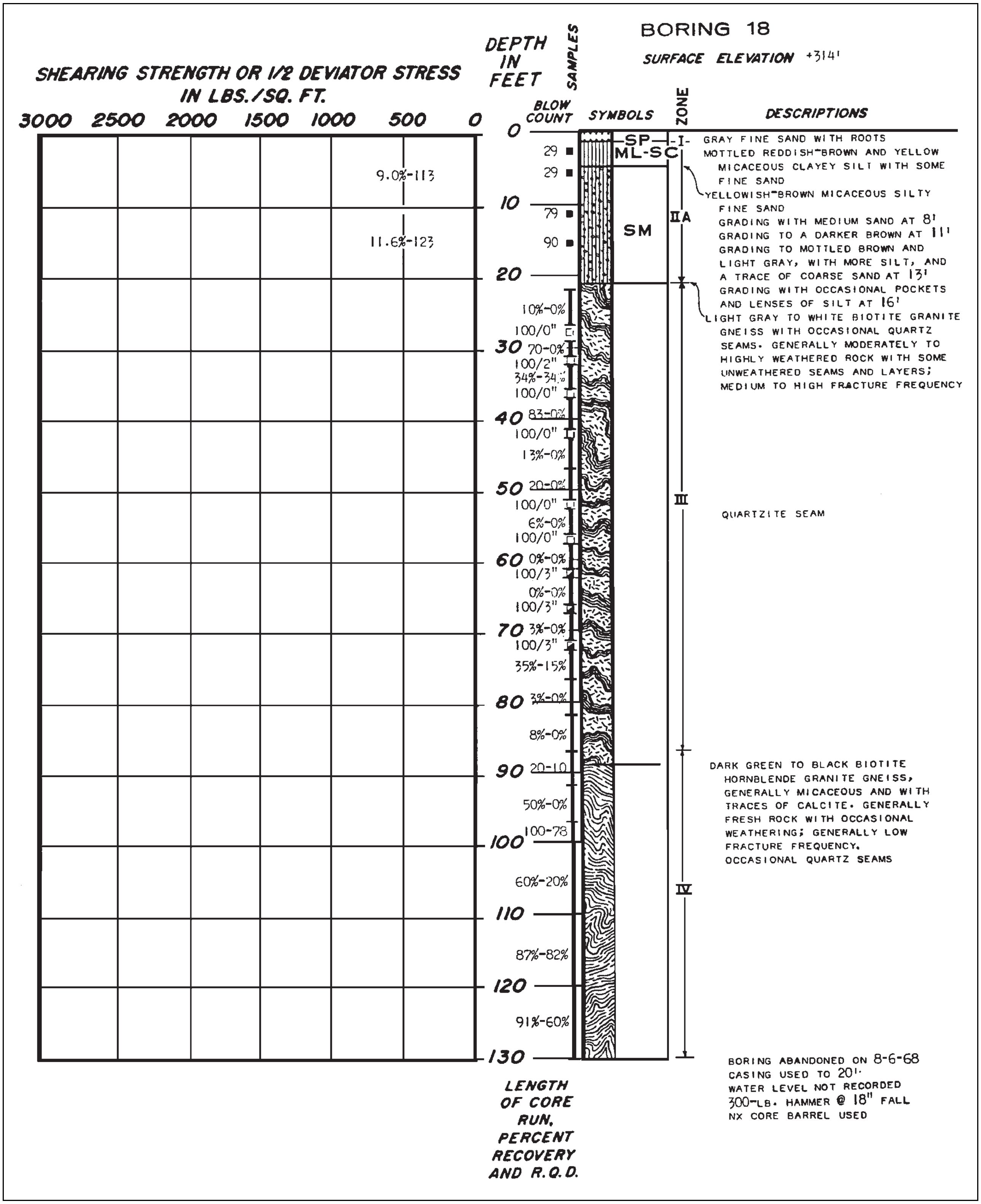


Figure 2.5-72 Log of Boring B-18

Chapter 3 Design of Structures, Components, Equipment, and Systems

3.5.1.6 Aircraft Hazards

Information regarding aircraft hazards is contained in SSAR Section 2.2.2.6 and Section 2.2.3.2.

Section 3.5 References

None

Chapter 13 Conduct of Operations

13.3 Emergency Planning

13.3.1 Emergency Planning Overview

This chapter provides the emergency planning information required by NRC regulations necessary to support an ESP application. That includes information required by 10 CFR 52.17(b)(1) regarding identification of potential impediments to emergency planning, and information required by 10 CFR 52.17(b)(3) regarding descriptions of contacts and arrangements made with local, state and federal governmental agencies with emergency planning responsibilities.

13.3.2 Major Features Emergency Plan

A major features emergency plan is also included in accordance with 10 CFR 52.17(b)(2)(I) as part of this ESP application. The Major Features Emergency Plan takes advantage of the emergency planning resources, capabilities, and organization that Virginia Power has already established and currently maintains at the NAPS site. If Dominion were to proceed with the development of new units at the ESP site, it would enter into an arrangement with Virginia Power to coordinate and implement an integrated emergency plan, in effect extending the existing emergency planning and preparedness to the new units. However, because some aspects of emergency preparedness require detailed design information which does not yet exist, some details of the plan that would be specific to the new units cannot be fully described at this time. Thus only the major features of the emergency plan are provided at this time.

13.3.2.1 Identification of Physical Characteristics

Pursuant to 10 CFR 52.17(b)(1), physical characteristics unique to the ESP site have been analyzed to determine whether they could pose a significant impediment to the development of emergency plans. A preliminary analysis of the evacuation times, utilizing the evacuation time estimate (ETE) methods recommended in NUREG-0654, Revision 1, Supplement 2 (Section II), has been used to identify these characteristics, including seasonal recreational visitors around the lake, school populations, etc. (Reference 16). A description of the analysis methods and results is provided in the most recent ETE, referenced in Section 13.3.2.1.1 (Reference 42).

13.3.2.1.1 Site Characteristics

The ESP site is located on a peninsula along the southern shore of Lake Anna in Louisa County, Virginia. The existing units are licensed under provisions of Title 10 of the Code of Federal Regulations, Part 50 (License Numbers NPF-4 and NPF-7). The ESP site is approximately 40 miles north-northwest of Richmond, Virginia; 36 miles east of Charlottesville, Virginia; and 22 miles southwest of Fredericksburg, Virginia. An ISFSI, licensed under provisions of 10 CFR 72, is also located at the NAPS site (License Number SNM-2507). Emergency planning activities for the new units at the ESP site would be coordinated with emergency planning for the other licensed facilities at the NAPS site for an integrated emergency response. For example, an emergency declared under provisions of any current or future license may necessitate protective actions at shared facilities or at other licensed facilities. Response actions would be integrated to the extent necessary and addressed in future emergency plan implementing procedures, as appropriate.

ETEs have been calculated (in 1981, 1990–1991, and 2001) The NAPS Emergency Plan (NAEP) (Reference 24) requires that the existing ETE be provided to the Commonwealth of Virginia Department of Emergency Management (DEM) following the 10-year census. The purpose is to determine whether an updated ETE should be calculated for the NAPS plume exposure pathway Emergency Planning Zone (EPZ) described in Section 13.3.2.2.1.a.

13.3.2.1.2 **Evacuation Time Estimate Analysis**

The most recent ETE for the NAEP is based on Census 2000 data, and is applicable to the ESP site (Reference 42). The total permanent resident population within the plume exposure pathway EPZ for the existing units has been calculated to be 20,292 (the 1990–1991 and 1981 estimates were 20,196 and 14,610 respectively) (Reference 40) (Reference 41). This report breaks down the population numbers by 16 sectors and 2-mile, 5-mile, and 10-mile rings. The ETE considers permanent residents, transients, and persons in special facilities, including school populations.

Analyses of ETEs have identified no institutional populations in the EPZ other than public schools. The majority of the population is composed of permanent residents with seasonal recreational visitors on or around Lake Anna. Avenues of movement across the waterway are limited to seven crossings, one on the lower side of Lake Anna. However, emergency traffic is expected to flow away from the NAPS site (which includes the ESP site) rather than across the water. The road network is determined to be adequate to accommodate the vehicular traffic anticipated.

13.3.2.2 **Major Features of the Emergency Plan**

The major features of the emergency plan described herein have been prepared in accordance with 10 CFR 52.17(b)(2)(i), considering the guidance of NUREG-0654/FEMA-REP-1, Revision 1, Supplement 2. 10 CFR 50, Appendix E (Reference 5), has also been utilized. Optional information is included where appropriate.

The ESP site is one with pre-existing nuclear facilities that has existing state and local emergency plans. The ESP application, therefore, relies on and refers to information contained in these existing plans. No significant differences have been identified between major features proposed in the ESP application and the major features presented in existing plans and relied on in the ESP application.

Differences between emergency planning information relative to this chapter and the guidance provided by NUREG-0654, Supplement 2, including planning standards or evaluation criteria not addressed, are identified and explained in Section 13.3.4.

13.3.2.2.1 Emergency Planning Zones

Title 10, Code of Federal Regulations, Part 50, Appendix E, provides that the size of the EPZ for a nuclear power plant shall be determined in relation to local emergency response needs and capabilities. This is because the appropriate size of the EPZ depends on conditions surrounding the site including demography, topography, land characteristics, access routes, and jurisdictional boundaries. For nuclear power plants of 250 megawatts thermal or greater, Appendix E provides that the plume exposure pathway EPZ shall consist of an area about 10 miles (16 kilometers) in radius. Generic guidance for the ingestion exposure pathway emergency planning zone (IPZ) describes an area about 50 miles (80 kilometers) in radius.

When recommending the size of these EPZs in 1978, the NRC/EPA Task Force on Emergency Planning considered the 1975 Reactor Safety Study (WASH-1400). (Reference 12) The NRC/EPA Task Force on Emergency Planning determined that this study was the best available source of information on the relative likelihood of large accidental releases of radioactivity, given a core melt event (Reference 14).

Since that time, significant advances have been made in understanding the timing, magnitude, and chemical form of fission product releases from severe nuclear power plant accidents (Reference 11). This Major Features Emergency Plan has been developed assuming a plume exposure pathway EPZ of 10 miles in radius and an IPZ of about 50 miles in radius. The plan recognizes that the size of these areas is subject to change if later analyses, design-specific factors, and legislative or regulatory initiatives warrant.

a. **Plume Exposure Pathway Emergency Planning Zone**

   The plume exposure pathway EPZ is the area of interest associated with whole body external exposure to gamma radiation from a plume and deposited materials, and inhalation exposure from a passing radioactive plume. The duration of primary exposures could range in length from hours to days. The plume exposure pathway EPZ consists of an area about 10 miles in radius around the Dominion ESP site (See Figure 13.3-1). Parts of the Counties of Caroline, Hanover, Louisa, Orange, and Spotsylvania, Virginia, lie within the plume exposure pathway EPZ. Collectively, these counties are referred to as the risk jurisdictions. (Reference 31)

b. **Ingestion Exposure Pathway Emergency Planning Zone**

   The ingestion exposure pathway EPZ, that is, the IPZ, is the area of interest for exposure primarily from ingestion of water or foods such as milk and fresh vegetables that have been contaminated with radioactive materials. The duration of primary exposure could range from hours to months. The IPZ consists of an area about 50 miles in radius around the ESP site (See Figure 13.3-2). The Cities of Charlottesville, Fredericksburg and Richmond, Virginia; all or parts of the Counties of Albemarle, Amelia, Buckingham, Caroline, Chesterfield, Culpeper, Cumberland, Essex, Fauquier, Fluvanna, Goochland, Green, Hanover, Henrico, King and

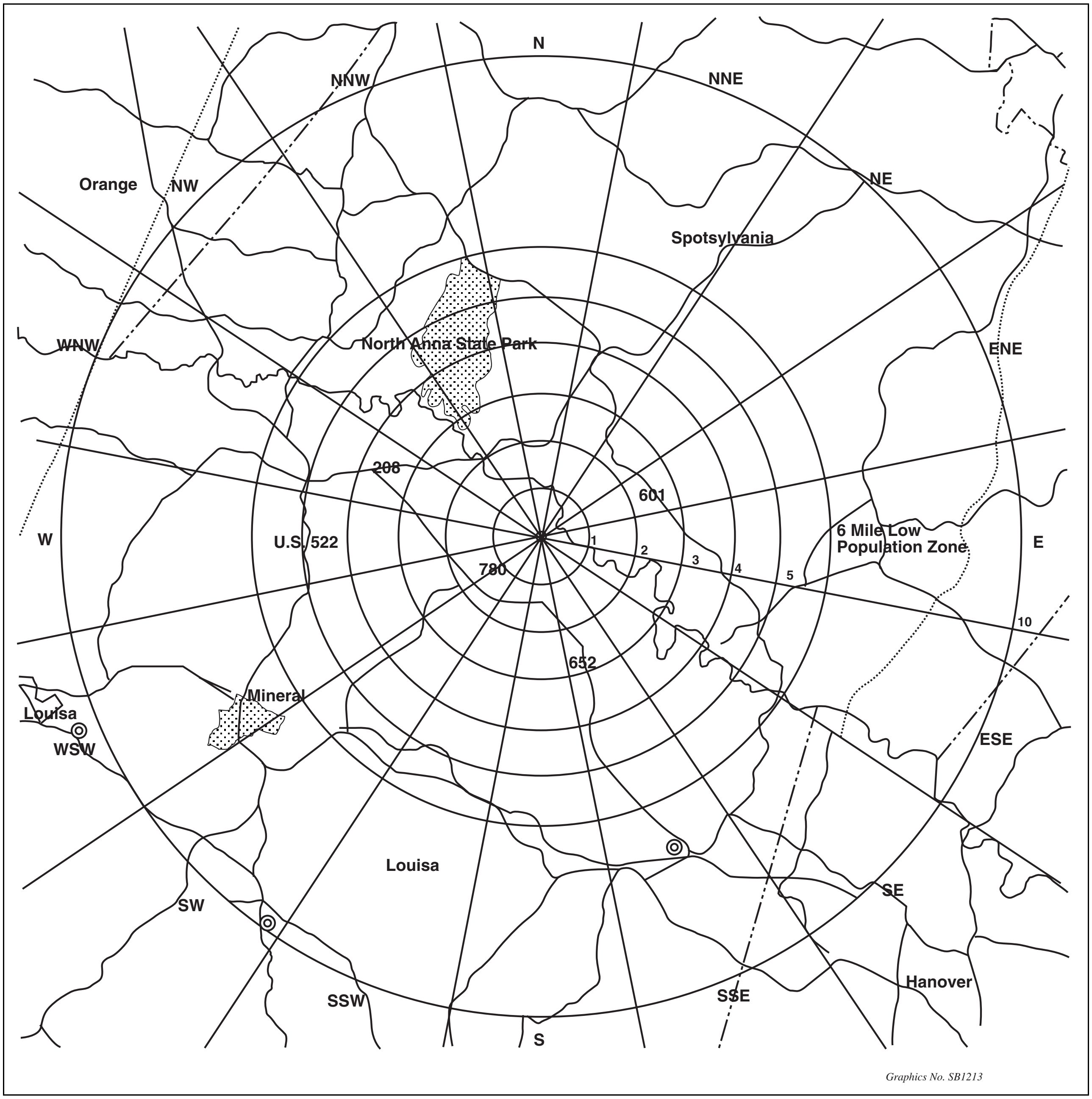


Figure 13.3-1 Plume Exposure Pathway Emergency Planning Zone

Queen, King George, King William, Louisa, Madison, Nelson, Orange, Page, Powhatan, Prince William, Rappahannock, Rockingham, Spotsylvania, Stafford, and Westmoreland, Virginia; and part of Charles County, Maryland, lie within the IPZ.

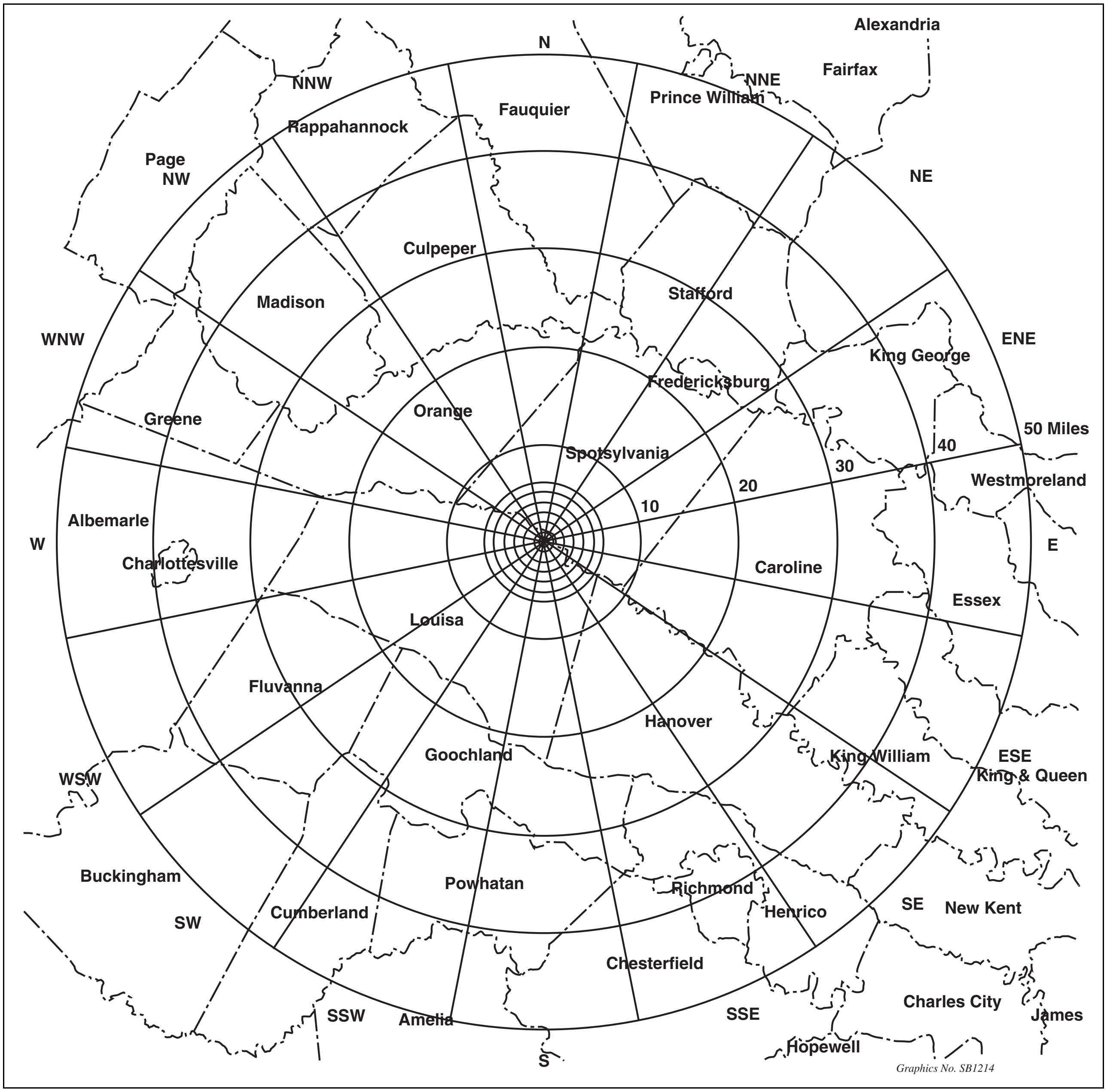


Figure 13.3-2 Ingestion Exposure Pathway Emergency Planning Zone

13.3.2.2.2 Planning Standards and Evaluation Criteria

NUREG-0654, Supplement 2, presents planning standards and evaluation criteria applicable for a major features emergency plan. The subsections that follow address these planning standards and evaluation criteria.

a. **Assignment of Responsibility (Organization Control)**

Primary responsibilities of risk jurisdiction response organizations, the Commonwealth of Virginia, the federal government, and private sector organizations are described below.

1. **Local Response Organizations**

The elected officials of local governments have responsibility for radiological emergency response within their jurisdictions. Because time is a major factor in realizing the benefits of protective action in the event of a radiological emergency, certain of these actions are predetermined and are implemented without delay upon notification of a radiological emergency.

In the event of an emergency of any classification made pursuant to emergency action levels (EALs) (Section 13.3.2.2.2.d), Dominion would notify response organizations as described in Section 13.3.2.2.2.e. Dominion would communicate with the Director of Emergency Services of each risk jurisdiction who has the capability of activating their Emergency Operations Centers (EOC). Dominion would rely on these jurisdictions to provide assistance in the event that an evacuation from the site requires a remote assembly point or for any services they are capable of providing to mitigate the results of the emergency.

The authority and responsibilities of Louisa County are presented in the Louisa County Radiological Emergency Response Plan (RERP) (Reference 32). The Louisa County RERP:

- Assigns responsibilities to county offices and organizations for radiological emergency response and preparedness
- Sets forth procedures for disseminating warning of radiological emergencies to the citizens of the county
- Specifies response actions for specific emergency classifications
- Delineates the policies and concepts under which the county government would operate during a radiological emergency response

Upon notification, the Louisa County Sheriff's Office would notify the County Coordinator of Emergency Services, or a designated representative, who would perform the following tasks:

- Verify the notification from the ESP site
- Initiate the key county official's alert system
- Iinitiate public warning procedures, as authorized by the Commonwealth of Virginia
- Prepare for evacuation of people from the affected area if authorized by the Commonwealth of Virginia

The County Coordinator of Emergency Services, or designated representative, would activate and ensure that the EOC is manned 24 hours a day when conditions warrant.

Once initial notifications are complete, Dominion's onsite emergency organization described in Section 13.3.2.2.2.b would provide periodic status reports to the County Coordinator of Emergency Services. These reports would include any changes in status or emergency classification. Prior to establishment of the County EOC the County Sheriff's Office would serve as the local point of contact for official communications within and outside of the county. When the EOC is established, this responsibility would transfer to the EOC.

The Sheriffs of Louisa and Spotsylvania Counties provide police support, traffic control, and additional security. They coordinate their efforts with the Virginia State Police (VSP), as described in Section 13.3.2.2.2.a.2.

The local county health department is the primary health response agency within the affected risk jurisdictions. Their efforts are coordinated with the VDH, as described in Section 13.3.2.2.2.a.2

The authority and responsibilities of Caroline, Hanover, Orange, and Spotsylvania Counties during a radiological emergency are presented in their respective RERPs. The existing RERPs apply to the radiological emergencies within these localities caused by events at the NAPS site and would apply to events at the ESP site. The Caroline, Hanover, Orange, and Spotsylvania County RERPs are identical to the Louisa RERP, as described above, except for information that is specific to the respective counties. (Reference 32) (Reference 33) (Reference 34) (Reference 35) (Reference 36)

2. **Commonwealth of Virginia Response Organization**

The Commonwealth of Virginia's organization for response to radiological emergencies is based on normal governmental structures and channels of communication. The Governor, in the role of Director of Emergency Management, directs the emergency response through the State Coordinator of Emergency Management. The State Coordinator of Emergency Management coordinates the overall response, and the VDH provides technical advice and assistance on radiological accident assessment, protective action, radiological control, and radiological monitoring.

The Virginia EOC is in Chesterfield County, Virginia. The Virginia DEM sends appropriate liaison personnel to the Emergency Operations Facility (EOF) upon activation.

In the event that an emergency of any classification is declared, pursuant to the Emergency Classification System Action Levels (Section 13.3.2.2.2.d), Dominion would make notifications as described in the section on Notification and Methods of Procedures (Section 13.3.2.2.2.e). Upon declaration of an Alert or higher emergency class, the DEM would notify the VDH (Radiological Health Program). The VDH would implement its response procedures in accordance with the Commonwealth of Virginia's RERP. As part of the planned response, a team is sent to the EOF to provide a direct interface between the VDH and Dominion's Emergency Response Organization (ERO). After the initial immediate actions, subsequent protective actions are taken based on the results of the Commonwealth of Virginia evaluation of the radiological situation and the company's recommendations. Commonwealth of Virginia and federal agencies provide assistance as required. VDH personnel, in coordination with the DEM, provide technical advice and assistance on radiological accident assessment, protective actions, radiological exposure control, and radiological monitoring. The VDH provides assistance to the local county health department emphasizing the special requirements for those individuals who are contaminated with radioactivity. Accident assessment personnel, as part of the Radiological Emergency Response Team, would operate from the Virginia EOC. More specific information is contained within the Commonwealth of Virginia RERP (Reference 31).

The Commonwealth of Virginia would also provide police support. In the event of an emergency, the dispatcher at the VSP headquarters is normally notified. The first response would most likely be from police units based in the local area. Additional units dispatched from other parts of the commonwealth would supplement these resources. The VSP would provide traffic control and additional security and would coordinate their efforts with those of the local law enforcement agencies (e.g., the local County Sheriffs of Louisa and Spotsylvania) as described in Section 13.3.2.2.2.a.1.

The VDGIF would provide assistance via their knowledge of local terrain and by monitoring Lake Anna.

Additional Commonwealth of Virginia organizations having possible responsibilities in a radiological emergency are listed in the Commonwealth of Virginia RERP, Annex I-V to Volume II, Appendix 2, Organization. Requests by Dominion for support services from these organizations would be coordinated through the DEM.

3. **Federal Response Organizations**

In the event that an emergency classification is made pursuant to the early action levels, Dominion would make notifications as described in Section 13.3.2.2.2.e. Dominion personnel would maintain contact with the NRC to ensure that accurate information and assessment of the emergency are available to the federal government.

Details of federal assistance are described in Section 13.3.2.2.2.c.

4. **Private Sector Response Organizations**

Support would be obtained from the cognizant Architect/Engineer, the Nuclear Steam Supply System vendor, and other consultants and vendors, as appropriate, to respond during the emergency and recovery operations. Experienced personnel with in-depth expertise in plant design, engineering, and construction would be involved to aid in solving critical technical problems. Dominion would identify these consultants and vendors, as necessary, when their relationship is referenced in a COL application.

Private-sector response may also include radiological laboratories and other facilities and organizations, as described in Section 13.3.2.2.2.c.

5. **Major Elements of Emergency Response: Functions and Responsibilities**

   The Virginia RERP and the risk jurisdiction RERPs apply to the radiological emergencies caused by events at the existing units and would also apply to events at the new units. The following major elements of emergency response are addressed therein.

   - Command and control
   - Alerting and notification
   - Communications
   - Public information
   - Accident assessment
   - Public health and sanitation
   - Social services
   - Fire and rescue
   - Traffic control
   - Emergency medical services
   - Law enforcement
   - Transportation
   - Protective response
   - Radiological exposure control

   The legal bases for these authorities are detailed in their respective plans. The DEM provides amendments to these plans to the Federal Emergency Management Agency. (Reference 7)

6. **Contacts and Arrangements**

   The existing licensed facilities maintain within the NAEP a letter of agreement with the DOE, Field Office, Oak Ridge, and with the following Commonwealth of Virginia agencies:

   - Department of Emergency Management
   - Department of Health

- Department of State Police
- Department of Game and Inland Fisheries
- Medical College of Virginia (MCV) Hospitals and Physicians, Virginia Commonwealth University (VCU) Health Systems

The existing licensed facilities maintain within the NAEP letters of agreement with the following local agencies:

- Louisa County Administrator
- Louisa County Volunteer Firefighter's Association
- Louisa County Sheriff
- Emergency Medical Services Association of Louisa County (Lake Anna Rescue, Inc., Louisa County Rescue Squad, Inc., Holly Grove Rescue Squad, Inc., Mineral Volunteer Rescue Squad, and Trevilians Volunteer Fire Department, Inc.)
- Spotsylvania County Sheriff
- Spotsylvania Volunteer Fire Department, Inc.
- Spotsylvania County Coordinator
- Orange County Sheriff
- Orange County Administrator
- Caroline County Department of Fire & Rescue
- Caroline County Sheriff
- Hanover County Administrator
- Hanover County Sheriff

Dominion provided an overview of the Dominion ESP project to DEM Management staff members on February 20, 2003 and to risk jurisdiction coordinators of emergency management on March 24, 2003. The NRC licensing process, emergency preparedness requirements for ESP applicants, and Dominion's schedule for preparing and submitting this ESP application were described. No impediment to pursuing an ESP has been identified by Commonwealth of Virginia or risk jurisdiction response organizations.

b. **Onsite Emergency Organization**

A description of the onsite emergency organization would be provided in a COL application. This onsite emergency organization would include an emergency coordinator, qualified in accordance with Section 13.3.2.2.2.o.1. The emergency coordinator would respond with the following actions:

- Classify and declare emergency classes as described in Section 13.3.2.2.2.d,

- Initiate notifications as described in Section 13.3.2.2.2.e,
- Approve any planned exposures greater than 10 CFR 20 annual limits when appropriate, as described in Section 13.3.2.2.2.k.

The onsite emergency organization would provide for the key functions of accident assessment, radiological monitoring and analysis, security, fire-fighting, first aid and rescue, and communications. (Reference 16)

1. **Interfaces**

   Interfaces between and among the onsite functional areas of emergency activity, local services support, and State and local government response organization are shown in Figure 13.3-3.

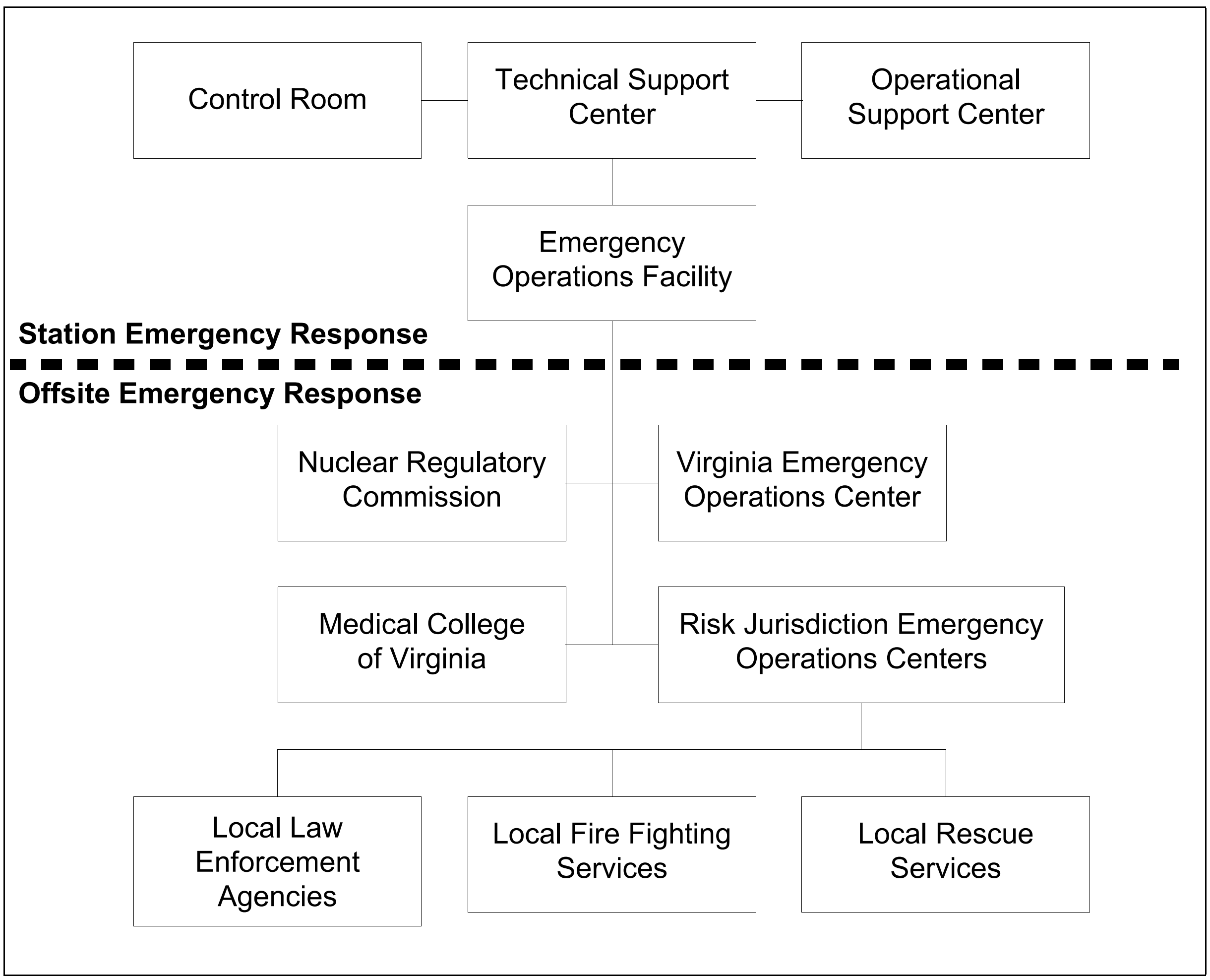


Figure 13.3-3 Onsite-Offsite Interface

2. **Services**

   The existing units maintain agreements for police, fire-fighting, rescue squad, medical, and hospital services. (Reference 24) These agreements would apply to the ESP site. Contacts and arrangements for these services are described in Section 13.3.2.2.2.a.6. Rescue squads meet the licensure requirements established by the VDH Office of Emergency Medical Services. (Reference 8)

   Provisions for maintaining agreements for services are described in Section 13.3.2.2.2.p.4, and Section 13.3.3.

c. **Emergency Response Support and Resources**

Circumstances prompting the implementation of an emergency response may necessitate augmentation of Dominion's resources. Such assistance may be requested from the federal government, radiological laboratories, and nuclear or other facilities and organizations.

1. **Federal Assistance**

   The Federal Response Plan (FRP) provides the mechanism for coordinating the delivery of federal assistance and resources to augment efforts of state and local governments overwhelmed by a major disaster or emergency. The FRP supports implementation of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as well as individual agency statutory authorities, and supplements other federal emergency operations plans developed to address specific hazards. The U.S. Department of Homeland Security (DHS) has primary responsibility for coordinating federal emergency preparedness, planning, management, and disaster assistance functions, including the establishment of federal disaster assistance policy. The DHS has the lead in developing and maintaining the FRP. (Reference 25)

   Under provisions of Homeland Security Presidential Directive 5, Management of Domestic Incidents, DHS has been assigned the task to develop a National Response Plan (NRP) that integrates the federal government's domestic prevention, preparedness, response, and recovery plans into one all-discipline, all-hazards plan. DHS also has been assigned the task to develop a National Incident Management System to provide a consistent nationwide approach for all levels of government to work effectively and efficiently together to prepare for, respond to, and recover from domestic incidents, regardless of their cause, size, or complexity. Dominion would incorporate these initiatives, as appropriate, in a COL application. (Reference 30)

   The Federal Radiological Emergency Response Plan (FRERP) (Reference 26) outlines the federal government's concept of operations based on specific authorities for responding to radiological emergencies. It also describes federal policies and planning considerations on which the concept of operations for the FRERP and federal agency-specific response plans are based, and specifies authority and responsibility of each federal agency that may have a significant role in such emergencies. The concept of operations for a response provides for the designation of one agency as the Lead Federal Agency (LFA) and for the establishment of on-scene, interagency response centers. In a response to an emergency involving a radiological hazard, the LFA under the FRERP is responsible for federal oversight of onsite activities and federal assistance in conducting radiological monitoring and assessment and developing protective action recommendations.

The NRC is the LFA for an emergency that occurs at a commercial nuclear power reactor. When a radiological emergency warrants action under the Stafford Act, DHS uses the FRP to coordinate the non-radiological response to consequences off site in support of the affected State and local governments. If the FRERP and FRP are implemented concurrently, the Federal On-Scene Commander (FOC) under the FRERP coordinates the FRERP response with the Federal Coordinating Officer (FCO), who is responsible for coordinating all federal support for state and local governments. The FRERP describes the responsibilities of both the LFA and other federal agencies that may be involved and the functions of each of the on-scene centers. Involved federal agencies include the following:

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Energy
- Department of Health and Human Services
- Department of Housing and Urban Development
- Department of the Interior
- Department of Justice
- Department of State
- Department of Transportation
- Department of Veterans Affairs
- Environmental Protection Agency
- Federal Emergency Management Agency
- General Services Administration
- National Aeronautics and Space Administration

- National Communications System
- Nuclear Regulatory Commission

Under provisions of the FRERP, DOE may respond to a state or LFA request for assistance by dispatching a Radiological Assistance Program (RAP) team (Reference 29). The DOE Regional Coordinating Office with responsibility for the geographic area where the ESP site is situated is the Oak Ridge Operations Office in Oak Ridge, Tennessee. The DOE Radiological Assistance Plan, Region 2, includes the states of Arkansas, Louisiana, Mississippi, Missouri, Tennessee, and West Virginia; the Commonwealths of Kentucky, Virginia, and Puerto Rico; and the U.S. Virgin Islands (Reference 27). If the situation requires more assistance than a RAP team can provide, DOE would alert or activate additional resources. These resources may include the establishment of a Federal Radiological Monitoring and Assessment Center (FRMAC) to be used as an on-scene coordination center for federal radiological assessment activities. The FRMAC is charged with defining and monitoring the radiological impact of a nuclear or radiological release. Because the effects of radiological contamination may last beyond an immediate emergency, FRMAC serves as a coordination point for radiological monitoring, assessment, evaluation, and reporting activities for the area surrounding a radiological incident, including decontamination, recovery, and long-term environmental monitoring. The FRMAC provides for the coordinated management of federal technical response activities related to a radiological emergency. It has three primary goals:

- Assisting the Commonwealth of Virginia and LFA with personnel, equipment, and technical resources, as needed
- Collecting offsite environmental radiological data
- Providing the relevant Commonwealth of Virginia agencies and the LFA offsite environmental radiological data and related assessments

A FRMAC advance party can be expected at the site within 6 to 14 hours following the order to deploy, depending on the availability of airports near the ESP site. Richmond International Airport is a major commercial facility, about an 85-minute drive from the ESP site. Smaller airports located within about an hour of the ESP site may also be used. (Reference 24)

Under provisions of the United States Government Interagency Domestic Terrorism Concept of Operations Plan, the operational response to a terrorist threat employs a coordinated, interagency process organized through the LFA concept. In this circumstance, responsibility is assigned to the DOJ and is delegated to the FBI. Initially, the FBI functions as the on-scene manager, while FEMA retains authority and responsibility to coordinate all federal assistance to state and local governments for consequence management. On-scene federal management transfers from the FBI to the FCO when directed by the Attorney General. (Reference 28)

2. **Radiological Laboratories**

   Radiological count laboratory resources are available through the Commonwealth of Virginia to respond to an emergency at the ESP site. These resources include those facilities listed below. Estimated travel times to the ESP site are provided parenthetically.

   - University of Virginia, Charlottesville, Virginia (45 minutes)
   - Virginia Commonwealth Laboratories, Richmond, Virginia (75 minutes)
   - MCV, Richmond, Virginia (75 minutes)
   - Newport News Shipbuilding & Drydock, Newport News, Virginia (3 1/2 hours)
   - VDH Radiological Health Program Mobile Laboratory (1 hour)

   If required at the time of the event, these additional resources can be obtained through purchase agreements with private institutions. These agreements would not be prepared in advance, but would be negotiated on an as-needed basis. (Reference 24)

3. **Assistance from Other Facilities and Organizations**

   Dominion Resources, Inc. (DRI), including its subsidiaries Virginia Power and Dominion, is one of the nation’s largest producers of energy. In 2003, DRI’s portfolio consisted of nearly 24,000 MW of electric power transmitted over 6,000 miles of transmission lines, 5.7 trillion cubic feet equivalent of natural gas reserves, 7,700 miles of natural gas pipeline, and the nation’s largest natural gas storage system with more than 960 billion cubic feet of storage capacity. In addition to the NAPS site, the nuclear program of the DRI companies consists of the Surry Power Station in Virginia and the Millstone Power Station in Connecticut (Reference 45). Assistance can be made available from these facilities and organizations as necessary. The EOF described in Section 13.3.2.2.2.h, would coordinate this assistance. Contacts and arrangements for assistance from outside the company are presented in the next subsection.

   Like other U.S. organizations that operate commercial nuclear power plants, Virginia Power is a member of the Institute of Nuclear Power Operations (INPO). INPO’s role in event of an emergency is to provide assistance in identifying and mobilizing the nuclear industry. Specifically, INPO facilitates technical information flow from the affected utility to the nuclear industry, locates replacement equipment and personnel with technical expertise, obtains technical information and industry experience regarding plant components and systems, and provides an INPO liaison to facilitate the interface between INPO and the member. To support these functions, INPO maintains a dedicated emergency notification system, designates INPO staff members to respond to requests for assistance, and maintains a dedicated Emergency Response Center. (Reference 38)

4. **Contacts and Arrangements for Assistance**

   Assistance from outside DRI's organization would be coordinated from the EOF described in Section 13.3.2.2.2.h. This includes interfaces with all levels of government and private sector response organizations, as described in Section 13.3.2.2.2.a, and other commercial nuclear operators as described in the sections that follow.

d. **Emergency Classification System**

The following emergency classification scheme would be used in the event of an emergency:

- Notification of Unusual Event – Unusual events are in process or have occurred which indicate a potential degradation of the level of safety of the plant. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of a safety system occurs.
- Alert – Events are in process or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant. Any releases are expected to be limited to small fractions of the EPA Protective Action Guideline exposure level.
- Site Area Emergency – Events are in process or have occurred which involve actual or likely major failures of plant functions needed for protection of the public. Any releases are not expected to exceed EPA Protective Action Guideline exposure levels at or beyond the site boundary.
- General Emergency – Events are in process or have occurred which involve actual or imminent substantial core degradation or melting with potential loss of containment integrity. Releases can be reasonably expected to exceed EPA Protective Action Guideline exposure levels offsite for more than the immediate site area.

1. **Emergency Action Levels**

   EAL criteria would be used to determine the need for notification and participation of local agencies, the Commonwealth of Virginia, the NRC, and other federal agencies. EAL criteria discriminate between the emergency classification scheme levels described in Section 13.3.2.2.2.d. The EALs would be used for determining when and what type of protective measures should be considered within and outside the NAPS site boundary to protect health and safety.

   The classification system is not intended to include minor deviations during normal operation. It may be discovered that an event or condition that met the classification criteria had existed, but the basis for declaration of the emergency class no longer exists at the time of discovery. For example, the event may have rapidly concluded or been discovered during a post-event review. Actual declaration of an emergency class is not warranted in these circumstances, although notification to the NRC and the DEM is necessary.

The EALs and plant-specific initiating conditions would be based on in-plant conditions and instrumentation, onsite and offsite monitoring, and hazards to station operation (e.g., as set forth in Appendix 1 of NUREG-0654/ FEMA-REP-1, Revision 1; RG 1.101, Revision 3; or other applicable documents) (Reference 9) (Reference 15). Dominion would propose site-specific EALs in the COL application. These EALs would be discussed and agreed on with the Commonwealth of Virginia and local governmental authorities and submitted to the NRC for approval. Thereafter, they would be reviewed with the Commonwealth of Virginia and local governmental authorities on an annual basis. After initial approval, changes to these EALs and initiating criteria would be made without NRC approval only if the changes do not decrease the effectiveness of the plans and the revised plans continue to meet the standards of 10 CFR 50.47(b)(4) and the requirements of 10 CFR 50, Appendix E.

2. **Emergency Classification Levels**

The Commonwealth of Virginia RERP and local government RERPs would provide an emergency classification level scheme consistent with that established by Dominion as required by 44 CFR 350.5(a)(4).

e. **Notification Methods and Procedures**

Dominion would provide means for notifying the Commonwealth of Virginia and risk jurisdictions, ERO personnel, and the populace within the plume exposure pathway's EPZ described in Section 13.3.2.2.1.a.

1. **Basis for Notification**

Upon initial classification and declaration of an emergency class, as described in Section 13.3.2.2.2.d, an individual qualified in accordance with radiological emergency response training (Section 13.3.2.2.2.o) would assume emergency coordinator responsibilities. This individual would initiate notifications applicable to the emergency class and event.

The Commonwealth of Virginia and risk jurisdictions would be notified promptly following declaration of an emergency class, including any classes that are immediately terminated. The capability for notifying these agencies within 15 minutes after declaring an emergency would be maintained (Reference 5). The content of the notification would include the class of the emergency and information regarding whether a release is in progress. The Commonwealth of Virginia would be notified of any recommended protective measures. Additional information, including meteorological data, would be provided in later notifications as it becomes available (Reference 15). As described in the EALs section (Section 13.3.2.2.2.d), the Commonwealth of Virginia would be notified if it is discovered that an event or condition that met the classification criteria, had existed, but that the basis for declaration of the emergency class no longer existed at the time of discovery (Reference 19).

The NRC Operations Center would be notified immediately thereafter and not later than one hour after the classification of an emergency as described in Section 13.3.2.2.2.d. The ERDS would be activated as soon as possible but not later than one hour after declaring an emergency class of alert, site area emergency, or general emergency. An open, continuous communication channel with the NRC Operations Center would be maintained upon request by the NRC (Reference 4).

2. **Alerting, Notifying and Mobilizing Emergency Response Personnel**

   At the Notification of Unusual Event emergency class, onsite notification would be limited to personnel involved in event response and the NRC Senior Resident Inspector.

   Dominion's ERO and uninvolved onsite personnel would promptly be made aware of an emergency that is initially classified and declared as an Alert or higher event promptly, unless doing so poses a threat to personnel safety. Severe weather and a security breach are examples of situations that may dictate suspension or deferral of the processes for alerting, notifying, and mobilizing emergency response personnel. However, these activities would be implemented as quickly as achievable, given the specific situation. The normal processes for alerting, notifying, and mobilizing the ERO are multifaceted, including alarms, announcements, pagers, telephones, on-line messages, etc.

   NAPS site personnel, including security personnel, and/or personnel from the VDGIF would alert individuals within the Exclusion Area.

3. **Means for Notifying and Instructing the Public**

   Protective Action Zones (PAZ), primary evacuation routes, and evacuation assembly centers (EAC) have been established in the event that an evacuation is recommended. This information is published and distributed by the Commonwealth of Virginia (Reference 31).

   Dominion would rely on the already installed Alert and Notification System (ANS) already installed around the NAPS site to support the new units. Sirens have been installed using the guidance contained in NUREG-0654/FEMA-REP-1, Revision 1, and FEMA-REP-10 (Reference 21). The purpose of the ANS is to ensure that essentially 100 percent of the population within 5 miles of the site can be alerted within 15 minutes and that essentially 100 percent of the population from 5 to 10 miles from the site who may not have received the initial notification can be alerted within 45 minutes (Reference 15). The FEMA approved the ANS for the existing units in 1987, pursuant to 44 CFR 350 (Reference 44). Virginia Power is responsible for maintaining and periodically testing the ANS, including sirens located throughout the plume exposure pathway EPZ described in Section 13.3.2.2.1.a.

The Commonwealth of Virginia and risk jurisdictions have ultimate responsibility for warning the public. Should it be necessary, Commonwealth of Virginia and local authorities, with the assistance of the VSP, would alert the public within the plume exposure pathway EPZ described in Section 13.3.2.2.1.a. The primary method of alerting the public is by sounding the ANS sirens. Other alerting methods may include telephone communications, television and radio communications via the Emergency Alert System (EAS) stations, public address systems, bull horns from patrol cars, and personal contact. Details are provided in the Commonwealth of Virginia RERP and local RERPs.

Members of the public within the plume exposure pathway EPZ described in Section 13.3.2.2.1.a would be informed of what actions to take after being alerted. Upon being alerted, they would be instructed to turn on their radios or television sets to the EAS to receive further instructions. Louisa and Spotsylvania Counties and the Commonwealth of Virginia have 24-hour-a-day capability to activate the ANS sirens. The Commonwealth of DEM prepares messages sent out over the EAS. Written, pre-planned messages intended for transmittal to the public via radio and television stations would be consistent with the emergency classification level scheme described in Section 13.3.2.2.2.d. The messages would give instructions with regard to specific actions to be taken by the occupants of the inhabited area. The messages would, as appropriate, give instructions on the nature of the emergency and information concerning the recommended protective action, sheltering, thyroid blocking potassium iodide, or evacuation. (Reference 31)

f. **Emergency Communications**

Dominion would provide the means for prompt communications with the Commonwealth of Virginia, risk jurisdiction, and federal government EROs; the means to alert and activate the ESP site ERO; and arrangements for communicating with medical support facilities.

1. **Communication With the Commonwealth of Virginia**

   Dominion would maintain the capability for notifying the Commonwealth of Virginia within 15 minutes after declaring an emergency as described in Section 13.3.2.2.2.d would be maintained (Reference 5). The content of the notification is described in Section 13.3.2.2.2.e (Reference 15).

2. **Communication With the Risk Jurisdictions**

   Dominion would maintain the capability for notifying the risk jurisdictions within 15 minutes after declaring an emergency as described in Section 13.3.2.2.2.d would be maintained (Reference 5). The content of the notification is described in Section Section 13.3.2.2.2.e (Reference 15).

3. **Communication With Federal Response Organizations**

   Dominion would maintain the capability for notifying the NRC Operations Center immediately after notifying the Commonwealth of Virginia and the risk jurisdictions, and not later than one hour after classifying an emergency, as described in Section 13.3.2.2.2.d, would be maintained (Reference 4). Requests for federal assistance would be communicated to the LFA as described in Section 13.3.2.2.2.c, or the cognizant department, agency, bureau, or service, as appropriate (Reference 29).

4. **Communication With the Dominion Emergency Response Organization**

   The ESP site ERO would be alerted for activation via multiple communications methods, e.g., plant alarms and/or announcements, pagers, telephones, on-line messages, etc.

5. **Communication With Medical Support Facilities**

   Communication can be maintained with the hospital service described in Section 13.3.2.2.2.l, from the ESP site. The ESP site would also be able to communicate with the ambulance by use of an ultra-high frequency radio or mobile telephone, and the ambulance can communicate with the hospital service by way of the Hospital Emergency and Administrative Radio system or mobile telephone.

g. **Public Education and Information**

Dominion would implement an emergency information program for the public and the news media.

1. **Informing the Public**

   Information describing the emergency notification process and actions that should be taken in the event of an emergency is provided to the public within the NAPS site plume exposure pathway EPZ on an annual basis, as described in Section 13.3.2.2.1.a. The following information is provided to the public:

   - Educational information on radiation
   - Contact points for obtaining additional information
   - Protective measures (e.g., evacuation routes and relocation centers, sheltering, respiratory protection, radio-protective drugs)
   - Special needs of the handicapped and the transient population

   (Reference 22)

   Dominion would coordinate its public information efforts with the Commonwealth of Virginia and local authorities to ensure that the public is informed by using the best means available. These means may include the following:

   - Information in telephone books

- Utility bill inserts
- Postings in public areas
- Publications (e.g., brochures, calendars) distributed on a periodic basis

Dominion intends to rely on the already established Virginia Power program for informing the public in the area surrounding the ESP site (Reference 24).

2. **Informing the News Media**

A program to acquaint the news media with the following information is offered on an annual basis:

- Emergency plans
- Information concerning radiation
- Points of contact for release of public information in an emergency

Dominion intends to rely on the already established program for informing the media in the area surrounding the ESP site.

h. **Emergency Facilities and Equipment**

Dominion would make provisions for emergency facilities and equipment to support an emergency response. However, because the detailed information needed to support a complete description of emergency facilities and equipment is not available at this time, Dominion does not seek approval of this major feature. This discussion in this subsection is provided only for general information and completeness.

1. **Technical Support Center**

Dominion would make provisions for a TSC located near the control room. Personnel reporting to the TSC would plant provide management and technical support to the control room staff during emergency conditions. The TSC would have technical and data displays and plant records available to assist in the detailed analysis and diagnosis of abnormal plant conditions. The TSC would be the primary onsite communications center for the plant during an emergency. (Reference 18)

2. **Operational Support Center**

Dominion would provide for an Operational Support Center (OSC) assembly area separate from the control room and the TSC. Personnel reporting to the OSC can be assigned duties in support of emergency operations. (Reference 18)

3. **Emergency Operations Facility**

Dominion would provide for an EOF for the management of the overall licensee emergency response (including coordination with federal, Commonwealth of Virginia, and risk jurisdiction officials), coordination of radiological and environmental assessments, and determination of recommended public protective actions. The EOF would have technical and data displays and plant records available to assist in the diagnosis of plant conditions. The EOF staff would evaluate the potential or actual release of radioactive materials to the environment. The EOF would be the primary offsite communications center for the plant during an emergency. (Reference 18)

4. **Emergency Operations Centers**

   The Commonwealth of Virginia and the risk jurisdictions have established EOCs for use in directing and controlling emergency response functions.

i. **Accident Assessment**

Dominion would provide methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition.

1. **Contacts and Arrangements for Meteorological Information**

   The existing units' Meteorological Monitoring System has the capability for collecting data used for making near real-time predictions of the atmospheric effluent transport and diffusion. The primary tower and backup tower have been sited to provide an accurate representation of regional meteorological conditions (Reference 23). The data would be accessible to the new unit's control room, the TSC, and the EOF (Reference 18). Suitable meteorological information would be made available to the Commonwealth of Virginia as described in Section 13.3.2.2.2.e (Reference 15).

   The NOAA is the primary agency within the DOC responsible for providing assistance to the federal, state, and local organizations responding to a radiological emergency under provisions of the FRERP as described in Section 13.3.2.2.2.c. Within NOAA, the NWS is the primary source of weather data, forecasts, and warnings for the United States. The Weather Forecast Office Baltimore/Washington in Sterling, Virginia, has jurisdiction over the area of the Dominion ESP site. (Reference 26)

2. **Contacts and Arrangements for Field Monitoring**

   Dominion would make provisions to obtain offsite data by field monitoring within the plume exposure pathway's EPZ described in Section 13.3.2.2.1.a. These field-monitoring activities would be coordinated from the EOF, described in Section 13.3.2.2.2.h. Dominion would coordinate its field monitoring efforts with the VDH under provisions of the Commonwealth of Virginia RERP (Reference 31).

3. **Contacts and Arrangements for Locating and Tracking Plume**

   Dominion and the Commonwealth of Virginia would rely on the DOE for airborne radioactive plume tracking under provisions of the FRERP as described in Section 13.3.2.2.2.c. (Reference 26) (Reference 27) (Reference 29) (Reference 31)

j. **Protective Response**

This section describes a range of protective actions for the public and emergency workers in the plume exposure pathway EPZ (Section 13.3.2.2.1.a), guidelines for choosing protective actions during an emergency, and protective actions associated with the IPZ.

1. **Evacuation of Onsite Individuals**

   Emergency assembly areas have been established outside the existing units Protected Area to facilitate the dissemination of information to personnel. The same areas would be used to support the new units. Dominion may elect to direct an early personnel release in the absence of radiological or chemical agents necessitating evacuee monitoring. If evacuation of onsite individuals is necessary, evacuees would be directed to either the primary or secondary remote assembly area (RAA) depending on specific radiological and environmental conditions. (see Figure 13.3-4)

   Evacuees would use personal vehicles for transportation. Evacuees would be surveyed for contamination following events involving a release, and would be decontaminated, if necessary, prior to being released from the RAA. Decontamination agents and supplies are available at the NAPS site and can be transported to the RAAs to provide decontamination capabilities. (Reference 24)

2. **Protective Action Recommendations**

   The senior Dominion representative in the EOF (or the senior Dominion representative in the Control Room or TSC if the EOF is not yet activated) would be responsible to the Commonwealth of Virginia for recommending offsite protective actions. The Commonwealth of Virginia and risk jurisdictions are responsible for notifying the public and implementing the appropriate protective measures as described in Section 13.3.2.2.2.e.3. Protective action recommendations are to be made to the Commonwealth of Virginia within 15 minutes of declaring a General Emergency under provisions of Section 13.3.2.2.2.d. It is anticipated that the initial protective action recommendation is to be based on plant conditions. Follow-up protective action recommendations that Dominion may make to the Commonwealth of Virginia would be based on current meteorological data such as wind direction, wind speed and stability class, and dose projections. This guidance is based on NUREG-0654/FEMA-REP-1, Supplement 3, and EPA 400-R-92-001 (Reference 17) (Reference 22).

3. **Evacuation Time Estimates**

   The most recent NAEP ETE, based on Census 2000 data, is applicable to the ESP site. Evaluation time estimates based on different affected population areas and weather conditions range from 85 minutes to 105 minutes. (Reference 42)

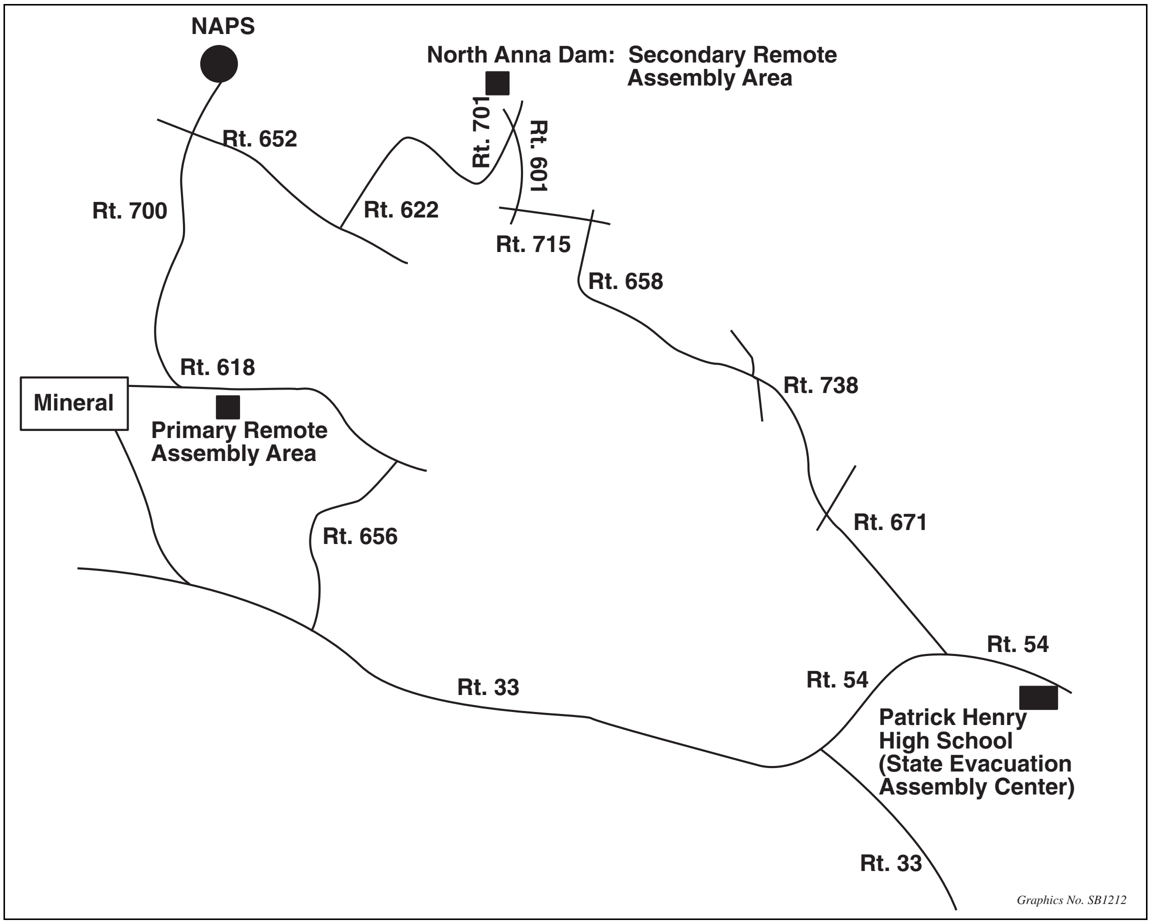


Figure 13.3-4 Remote Assembly Areas

4. **Implementation of Protective Measures**

   The most recent NAEP ETE includes maps showing the site and the plume exposure pathway EPZ described in Section 13.3.2.2.1.a, transportation networks (evacuation routes), topographical features, political boundaries, and PAZ. Population information is presented in a 2-mile, 5-mile and 10-mile ring and 16-sector format map. Population information is presented in tables by 2-mile, 5-mile and 10-mile ring and 16-sector format and by PAZ.

   The means for notifying the transient and resident population is described in Section 13.3.2.2.2.e.3.

k. **Radiological Exposure Control**

Dominion would make provisions for controlling radiological exposures of emergency workers in an emergency.

1. **Guidelines on Dose Limits**

   Dominion would maintain dose within the limits of 10 CFR 20 limits under normal operating conditions. (Reference 1) Emergency response personnel may, because of necessity, receive a once-in-a-lifetime exposure to contamination and radiation up to the 10 CFR 20 annual limits, not including accumulated occupational exposure. These limits apply to the following activities:

   - Removing injured persons
   - Undertaking corrective actions
   - Performing assessment actions
   - Performing field radiological measurements in the plume exposure pathway EPZ described in Section 13.3.2.2.1.a
   - Providing first aid
   - Performing personnel decontamination
   - Providing ambulance service
   - Providing medical treatment services
   - Exposure in excess of these limits would be controlled as described in Section 13.3.2.2.2.k.4.

2. **Onsite Radiation Protection Program**

   Emergency exposure may be authorized for such needs as removal of injured personnel, undertaking corrective actions, performing assessment actions, providing first aid, performing personnel decontamination, providing ambulance service, providing medical treatment, etc. Guidelines for emergency exposure limits are consistent with EPA Emergency Worker and Life Saving Activity Protective Action Guides. (Reference 20).

   The existing units radiological protection procedures specify levels of permissible radioactive contamination for workers and equipment. Actions are required to be taken when levels for equipment or areas exceed these limits. Any detected personnel contamination initiates appropriate evaluation and decontamination in accordance with these procedures. These procedures would be applicable for the ESP site or this function would be addressed in future radiological protection procedures.

   The existing units have onsite contamination control procedures that provide for access control. These procedures state the criteria for permitting the return of the areas and their contents to normal use. These procedures would be applicable for the ESP site or this function would be addressed in future radiological protection procedures.

   No food supplies are grown on the ESP site and the water supplies come from deep wells (Reference 23). The existing units have procedures to monitor contamination in areas designated as permissible for employees to eat and drink during the emergency and recovery phases of operations. These procedures would be applicable for the ESP site or this function would be addressed in future radiological protection procedures.

3. **Tracking Doses**

   Emergency workers at the ESP site would receive direct reading and permanent record dosimeters. Dose records would be maintained in accordance with existing units radiological protection procedures or future radiological protection procedures.

4. **Authorization of Exposure Above Dose Limits**

   Approval from the emergency coordinator is necessary for planned exposures greater than the 10 CFR 20 annual limits. Under limited circumstances, exposure levels greater than 5 times the 10 CFR 20 annual limits may be allowed, but only on a voluntary basis to persons fully aware of the risks involved. Selection criteria for volunteer emergency workers includes consideration of those who are in good physical health, are familiar with the consequences of emergency exposure, and are not a declared pregnant adult. It is preferable, though not mandatory, that volunteers be older than 45 years of age and not be females capable of reproduction. (Reference 1) (Reference 20)

Table 13.3-1 Dose Limit Guidelines

Emergency Worker Activity	Dose Limit	Condition
All	5 Rem TEDE	
Protecting valuable property	10 Rem TEDE	Lower dose not practicable.
Lifesaving or protection of large populations	25 Rem TEDE	Lower dose not practicable.
Lifesaving or protection of large population	>25 Rem TEDE	Only on a voluntary basis to persons fully aware of the risks involved.

TEDE = Total effective dose equivalent.

5. **Decontamination**

   If onsite personnel are required to relocate or routinely leave the site during an emergency, Dominion would provide adequate supplies for personnel decontamination, clothing, and a means for decontaminating the clothing. If radio-iodine contamination of the skin is determined, or needed supplies, instruments, or equipment are contaminated; then provisions would be made to provide for decontamination as specified in the existing units' radiological protection procedures or this function would be addressed in future radiological protection procedures. (Reference 24)

Health Physics personnel can perform the decontamination task at the existing units or the ESP site, the RAA, or if necessary, at Patrick Henry High School in Hanover County. (Reference 34)

Personnel with wounds that become contaminated would be decontaminated to the extent achievable or prepared for transport to the hospital service described in Section 13.3.2.2.2.l. (Reference 24)

l. **Medical and Public Health Support**

Dominion would make contacts and arrangements for medical services for contaminated injured individuals.

1. **Arrangements for Hospital Services**

   Virginia Power has made arrangements with the MCV in Richmond, Virginia, to provide medical assistance to personnel injured or exposed to radiation and/or radioactive material. MCV has developed its own emergency plan, designed to provide medical care in the case of a radiation emergency. The MCV Radiation Emergency Plan supports the NAPS site in case of occupational and/or major accidents, including contaminated personnel. MCV's plan establishes a specialized area of the hospital for treatment with appropriate Health Physics functions, and implements a coded system to alert hospital team members. Radiation monitoring equipment, dosimetry, and protective clothing are available at MCV.

   Based on the quality of the facilities at MCV, the NRC has accepted the absence of arrangements for a back-up hospital. (Reference 13) Arrangements for the use of MCV's facilities would apply to the ESP site. In the event of a need for their support, a call ahead to MCV would be made to alert them to activate their Radiation Emergency Plan. (Reference 37)

2. **Arrangements for Medical Services**

   The Commonwealth of Virginia Radiation Emergency Response Plan contains lists indicating the location of public, private, and military hospitals and other medical service facilities within the Commonwealth of Virginia that are capable of providing medical support for any contaminated or injured individual. The listing includes the name, location, type of facility, capacity, and radiological capabilities. Contacts and arrangements are described in the plan.

m. **Recovery and Re-entry Planning and Post-Accident Operations**

NUREG-0654, Supplement 2, Section V, deems that the Recovery and Re-entry Planning and Post-accident Operations planning standard is inappropriate for the ESP application. This section is included herein to conform to the emergency plan structure anticipated for a COL application.

n. **Exercises and Drills**

NUREG-0654, Supplement 2, Section V, deemed that the Exercises and Drills planning standard is inappropriate for the ESP application phase. This section is included herein to conform to the structure anticipated for a COL application's Emergency Plan.

o. **Radiological Emergency Response Training**

Personnel designated to fill ERO positions at the existing units receive training in accordance with the Nuclear Power Station Emergency Preparedness Training (NPSEPT) Program Guide. The NPSEPT Program Guide contains the curriculum design and requirements for program management, implementation, evaluation, and documentation. Emergency preparedness training not conducted by the Nuclear Emergency Preparedness (NEP) staff is conducted pursuant to supporting department training program guidance. NEP verifies that this departmental training is consistent with the provisions of the NPSEPT Program Guide. These training programs, taken collectively, establish the initial training and retraining requirements for the existing units' ERO positions.

The existing units' Site Vice-President is responsible for ensuring that station personnel are trained in accordance with the NPSEPT Program Guide. Department directors, managers, and supervisors are responsible for ensuring that their personnel receive training. The Director Nuclear Protection Services and Emergency Preparedness is responsible for developing and scheduling training programs that meet the requirements of this plan and for maintaining records to document the training. NEP personnel, other than those designated to develop training programs, independently verify that the training required by the NPSEPT Program Guide is accomplished.

Dominion intends to rely on the existing NPSEPT Program Guide to provide the framework for conducting specialized initial training and periodic retraining for Dominion personnel at the new units. Specific training requirements for ERO personnel supporting the new units would be incorporated into the NPSEPT Program Guide.

1. **Training for Response Organization Coordinators**

   Emergency Plan training for ERO coordinators would address assessing emergencies, emergency assessment and classification, notification systems, site evacuation, emergency radiation exposure authorization, offsite support group capabilities, organizational interfaces and recovery.

2. **Training for Accident Assessment**

   Emergency Plan training for ERO accident assessment personnel would address the means for determining the magnitude of and for continually assessing the impact of the release of radioactive materials, including EALs for event classification and means for determining when and what type of protective measures should be considered within and outside the site boundary to protect health and safety.

3. **Training for Radiological Monitoring and Analysis**

   Emergency Plan training for personnel performing the radiological monitoring and analysis functions would address control of ERO personnel performing radiological monitoring and analysis, dose assessment, emergency exposure evaluation, and protective measures.

4. **Training for Police, Security, and Fire-Fighting Personnel**

   Dominion has no police powers. Training for local law enforcement agencies is addressed in Section 13.3.2.2.2.o.6. Emergency Plan training for onsite security personnel would address emergency organizational interfaces and communications systems to supplement training which would be described in a COL application. Emergency Plan training for onsite fire-fighting personnel would address emergency organizational interfaces and communications systems to supplement training, which would be described in a COL application.

5. **Training for First Aid and Rescue Personnel**

   Emergency Plan training for onsite first aid personnel would address emergency organizational interfaces and communications systems that would be described in a COL application. Onsite fire-fighting personnel, who provide the onsite rescue functions, are described in Section 13.3.2.2.2.o.4.

6. **Training for Local Support Services Personnel**

   The local support services personnel who support the existing units during an emergency receive training as part of their own emergency preparedness programs. For example, the Commonwealth of Virginia and local governments conduct training for their personnel as part of their RERP program. The existing units offers site-specific emergency response training on an annual basis to personnel in local support organizations that have agreed to provide assistance. The organizations include the Commonwealth of Virginia Department of State Police and local county sheriffs' departments, volunteer fire companies, and rescue squads. This annual training addresses the following topics:

   - The basic scope of the NAEP
   - Emergency classifications
   - Notification methods
   - Basic radiation protection
   - Station access procedure
   - The individual, by title, in the station ERO who would direct their activities onsite

- Definition of their support roles
- Site access procedures

The same or similar training would be provided to personnel providing local support services to the new units at the ESP site.

7. **Training for Medical Support Personnel**

Arrangements for medical support personnel who may support the existing units or the new units at the ESP site during an emergency are addressed in Section 13.3.2.2.2.l. The qualifications of personnel who may perform these functions are provided by their accrediting organization; such as, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). The existing units and the ESP site would respond to requests for site-specific emergency response training for medical support personnel who have agreed to provide assistance similar to that described in Section 13.3.2.2.2.o.6.

8. **Training for Communicators**

Emergency Plan training for ERO communicators would address notifications and reports to offsite authorities, communication and data acquisition systems and organizational interfaces.

p. **Responsibility for the Planning Effort**

Responsibility for the planning effort resides with Virginia Power's NEP Department. This department exists under the Nuclear Protection Services and Emergency Preparedness organization within Virginia Power's Nuclear Business Unit.

1. **Training for Individuals Responsible for the Planning Effort**

Individuals responsible for the planning effort would be afforded training commensurate with their duties and existing knowledge, skills and abilities. This may include site-specific offerings such as plant systems training and offerings from external sources, e.g., the FEMA Emergency Management Institute (EMI), the National Emergency Training Center, the Harvard School of Public Health, Nuclear Energy Institute (NEI), etc.

2. **Responsibility for Radiological Emergency Response Planning**

The Virginia Power Senior Vice President – Nuclear Operations and Chief Nuclear Officer, who possesses the overall authority for maintaining emergency preparedness, has delegated the responsibility for program implementation to the Senior Vice President – Nuclear Operations, and program maintenance to the Vice President – Nuclear Support Services. The Senior Vice President – Nuclear Operations has delegated the responsibility for NAPS site emergency preparedness to the NAPS Site Vice President. The Vice President – Nuclear Support Services has delegated the responsibility for maintaining emergency preparedness to the Director Nuclear Protection Services and

Emergency Preparedness. This responsibility would be extended to the ESP site. (Reference 23)

3. **Plan Development and Coordination**

   The Director-Nuclear Protection Services and Emergency Preparedness is responsible for developing the ESP site Major Features Emergency Plan and coordinating this plan with other response organizations. Provisions for maintaining this plan are addressed in Section 13.3.2.2.2.p.4. (Reference 23)

4. **Plan and Agreement Maintenance**

   NUREG-0654, Supplement 2, Section V, Evaluation Criterion P.4, provides that "[e]ach organization shall update its plan and agreements as needed." Following approval of the emergency planning information in the Dominion ESP site Major Features Emergency Plan, there is no requirement to update the plan or its supporting-organization agreements until after an operating license is issued. Dominion would update the emergency planning information as necessary in a COL application. Any changes that represent a decrease in the effectiveness of the previously approved information with respect to the standards of 10 CFR 50.47(b) or requirements of 10 CFR 50, Appendix E, would be specifically identified and addressed.

5. **Distribution of Emergency Plans**

   The ESP site Emergency Plan would be prepared when a COL application is made. Upon issuance, the Emergency Plan and approved changes thereto would be forwarded to organizations and appropriate individuals with responsibility for its implementation. Revised pages would be marked to show where changes have been made. Revised pages would be dated or marked with a revision number associated with an effective date.

6. **Emergency Plan Content**

   The ESP site major features emergency plan addresses the evaluation criteria contained in NUREG-0654, Supplement 2, Section V, as shown in Table 13.3-2 (Reference 16).

Table 13.3-2 Cross Reference to NUREG-0654, Supplement 2

Evaluation Criteria	Major Features Emergency Plan Section	Evaluation Criteria	Major Features Emergency Plan Section
A.1	13.3.2.2.2.a.1, 13.3.2.2.2.a.4	J.3	13.3.2.2.2.j.3
A.2.a – A.2.b	State & Local Plans Only	J.4.a – J.4.c	13.3.2.2.2.j.4
A.3	13.3.2.2.2.a.6	J.4.d – J.4.l	State & Local Plans Only
B.1	13.3.2.2.2.b.1	J.5	State & Local Plans Only
B.2	13.3.2.2.2.b.2	K.1.a – K.1.h	13.3.2.2.2.k.1
C.1	13.3.2.2.2.c.1	K.2	13.3.2.2.2.k.2
C.2	13.3.2.2.2.c.2	K.3.a – K.3.b	13.3.2.2.2.k.3
C.3	13.3.2.2.2.c.3	K.4	13.3.2.2.2.k.4
C.4	13.3.2.2.2.c.4	K.5.a – K.5.b	13.3.2.2.2.k.5
D.1	13.3.2.2.2.d.1	L.1	13.3.2.2.2.l.1
D.2	State & Local Plans Only	L.2	State Plan Only
E.1	13.3.2.2.2.e.1	M	Section 13.3.2.2.2.m
E.2	13.3.2.2.2.e.2	N	Section 13.3.2.2.2.n
E.3	13.3.2.2.2.e.3	O.1.a	13.3.2.2.2.o.1
F.1.a	13.3.2.2.2.f.1, 13.3.2.2.2.f.2	O.1.b	13.3.2.2.2.o.2
F.1.b	13.3.2.2.2.f.3	O.1.c	13.3.2.2.2.o.3
F.1.c	13.3.2.2.2.f.4	O.1.d	13.3.2.2.2.o.4
F.2	13.3.2.2.2.f.5	O.1.e	Omitted
G.1	13.3.2.2.2.g.1	O.1.f	13.3.2.2.2.o.5
G.2	13.3.2.2.2.g.2	O.1.g	13.3.2.2.2.o.6
H.1	13.3.2.2.2.h.1, 13.3.2.2.2.h.2	O.1.h	13.3.2.2.2.o.7
H.2	13.3.2.2.2.h.3	O.1.i	13.3.2.2.2.o.8
H.3	State & Local Plans Only	P.1	13.3.2.2.2.p.1
I.1	13.3.2.2.2.i.1	P.2	13.3.2.2.2.p.2
I.2	13.3.2.2.2.i.2	P.3	13.3.2.2.2.p.3
I.3	13.3.2.2.2.i.3	P.4	13.3.2.2.2.p.4
J.1	13.3.2.2.2.j.1	P.5	13.3.2.2.2.p.5
J.2	13.3.2.2.2.j.2	P.6	13.3.2.2.2.p.6

13.3.3 Contracts and Arrangements

Pursuant to 10 CFR 52.17(b)(3), a description of contacts and arrangements made with local, state, and federal governmental agencies with emergency planning responsibilities, and documentation thereof, is provided herein.

- U. S. Department of Energy – Field Office, Oak Ridge.
- Commonwealth of Virginia Department of Emergency Management
- Commonwealth of Virginia Department of Health
- Commonwealth of Virginia Department of State Police
- Commonwealth of Virginia Department of Game and Inland Fisheries
- MCV Hospitals and Physicians, VCU Health Systems
- Louisa County Administrator
- Louisa County Volunteer Firefighter's Association
- Louisa County Sheriff
- Emergency Medical Services Association of Louisa County
    - Lake Anna Rescue, Inc.
    - Louisa County Rescue Squad, Inc.
    - Holly Grove Rescue Squad, Inc.
    - Mineral Volunteer Rescue Squad
    - Trevilians Volunteer Fire Department, Inc.
- Spotsylvania County Sheriff
- Spotsylvania Volunteer Fire Department, Inc.
- Spotsylvania County Coordinator
- Orange County Sheriff
- Orange County Administrator
- Caroline County Department of Fire & Rescue
- Caroline County Sheriff
- Hanover County Administrator
- Hanover County Sheriff

Supporting organization agreements would be updated when referenced in a COL application.

Dominion provided an overview of the ESP project to DEM staff members on February 20, 2003 and to risk jurisdiction coordinators of emergency management on

March 24, 2003. The NRC licensing process, emergency preparedness requirements for ESP applicants, and Dominion's schedule for preparing and submitting this ESP application Anna were described at both meetings. During the discussions regarding the ESP process, no impediments to pursuing an ESP was identified by Commonwealth of Virginia or risk jurisdiction response organizations.

It is Dominion's understanding that the NRC would coordinate reviews and schedules relative to the ESP site's Major Features Emergency Plan with the Federal Emergency Management Agency (FEMA) in accordance with their current memorandum of understanding.

13.3.4 Conformance with NUREG-0652, Supplement 2

Differences between emergency planning information relative to this ESP application and the guidance provided by NUREG-0654, Supplement 2, including planning standards or evaluation criteria not addressed, are cross-referenced and described below:

Section	Description of Difference(s)
II	References to future emergency plan implementing procedures describing integration of response actions with current or future licensees are made herein.
III.A	The possible application of analyses performed subsequent to the WASH-1400 report, design-specific factors, and legislative or regulatory initiatives may affect the size of the plume exposure pathway EPZ described in Section 13.3.2.2.1.a and the IPZ described in Section 13.3.2.2.1.b is noted.
V.A.1	Private sector response from the Architect/Engineer and the nuclear steam system supplier are not addressed as these organizations have not yet been identified.
V.A.3 and V.B.2	Letters of agreement with supporting agencies are the existing letters of agreement in the NAEP.
V.C.1	Affect of the yet-to-be-issued NRP upon this plan are unknown.
V.C.2	Radiological count laboratory resources would be obtained through purchase agreements with private institutions. These purchase agreements are not prepared in advance, but would be negotiated on an as needed basis.
V.D.1	Emergency Action Levels may be developed in accordance with Appendix 1 of NUREG-0654/FEMA-REP-1, Revision 1, or RG 1.101, Revision 3; or other applicable guidance that may be available at the time application is made for a COL. RG 1.101, Revision 4, provides for use of an EAL scheme not referenced in NUREG-0654, Supplement 2 (Reference 16) (Reference 10). The yet-to-be-selected design may dictate use of yet another EAL scheme, or a site-specific model may be needed.
V.G.1	Emergency planning information, including that presented in the ESP Major Features Plan would be updated when it is referenced in a combined license application.

Section	Description of Difference(s)
V.J.4.a	Population information by PAZ is presented in tables rather than in a map.
V.J.4.b	Location of Emergency Assembly Centers are listed rather than appearing on a map.
V.K.2, V.K.3 and V.K.5	References to future radiological protection procedures are made herein.
V.L.1	Based on the quality of facilities at MCV, arrangements for a back-up hospital were excluded.
O.1.d and O.1.f	References to future Security Plan, Fire Protection Program and Accident Prevention Manual are made herein.
V.O.1.h	Provisions for responding to requests for site-specific emergency response training for medical support personnel are included in lieu of a description of a training program for instructing and qualifying such personnel.
V.P.5	Revised pages would be dated or marked with a revision number associated with an effective date in lieu of dating each page.

Section 13.3 References

1. 10 CFR 20, *Standards for Protection Against Radiation*, U.S. Nuclear Regulatory Commission.

2. 10 CFR 50.47, *Emergency Plans*, U.S. Nuclear Regulatory Commission.

3. 10 CFR 50.54, *Conditions of Licenses*, U.S. Nuclear Regulatory Commission.

4. 10 CFR 50.72, *Immediate Notification Requirements for Operating Nuclear Power Reactors*, U.S. Nuclear Regulatory Commission.

5. 10 CFR 50, Appendix E, *Emergency Planning and Preparedness for Production and Utilization Facilities*, U.S. Nuclear Regulatory Commission.

6. 10 CFR 52, *Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants*, U.S. Nuclear Regulatory Commission.

7. 44 CFR 350, *Review and Approval of State and Local Radiological Emergency Plans and Preparedness*, Federal Emergency Management Agency.

8. 12 VAC 5-31, *Virginia Emergency Medical Services Regulations*, Commonwealth of Virginia State Board of Health, April 23, 2003.

9. Regulatory Guide 1.101, *Emergency Planning and Preparedness for Nuclear Power Reactors*, Revision 3, U.S. Nuclear Regulatory Commission, August 1992.

10. Regulatory Guide 1.101, *Emergency Planning and Preparedness for Nuclear Power Reactors*, Revision 4, U.S. Nuclear Regulatory Commission, July 2003.

11. Regulatory Guide 1.183, *Alternative Radiological Source Terms For Evaluating Design Basis Accidents At Nuclear Power Reactors*, U.S. Nuclear Regulatory Commission, July 2000.

12. NUREG-75/014, *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, October 1975 (WASH-1400).

13. NUREG-0053, *Safety Evaluation Report related to the operation of North Anna Power Station, Unit 2*, Supplement No. 11, U.S. Nuclear Regulatory Commission, August 1980.

14. *NUREG-0396; EPA 520/1-78-016, Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, December 1978.

15. NUREG-0654/FEMA-REP-1, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, November 1980.

16. NUREG-0654/FEMA-REP-1, Supplement 2, *Criteria for Emergency Planning in an Early Site Permit Application*. Draft Report Comment, U.S. Nuclear Regulatory Commission, April 1, 1996.

17. NUREG-0654/FEMA-REP-1, Supplement 3, *Criteria for Protective Action Recommendations for Severe Accidents*, Draft Report of Interim Use and Comment, U.S. Nuclear Regulatory Commission, July 1, 1996.

18. NUREG-0696, *Functional Criteria for Emergency Response Facilities*, U.S. Nuclear Regulatory Commission, January 1, 1981.

19. NUREG-1022, *Event Reporting Guidelines: 10 CFR 50.72 and 50.73*, Revision 2, U.S. Nuclear Regulatory Commission, October 1, 2000.

20. EPA 400-R-92-001, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, Environmental Protection Agency, May 1992.

21. FEMA-REP-10, *Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants*, Federal Emergency Management Assistance, November 1985.

22. FEMA-REP-11, *Guide to Preparing Emergency Public Information Materials Federal Emergency Management Assistance*.

23. *North Anna Power Station Updated Final Safety Analysis Report*, Revision 38.

24. *North Anna Power Station Emergency Plan*, Revision 28, Dominion, July 1, 2003.

25. *Federal Response Plan*, Federal Emergency Management Agency, January 2003.

26. *Federal Radiological Emergency Response Plan (FRERP)*, Federal Emergency Management Agency, May 1, 1996.

27. *U.S. Department of Energy Radiological Assistance Program Region 2, Regional Plan*, U.S. Department of Energy, October 1997.

28. *United States Government Interagency Domestic Terrorism Concept of Operations Plan (CONPLAN)*, Department of Justice Federal Bureau of Investigation, January 2001.

29. U.S. Department of Energy Order 151.1A, *Comprehensive Emergency Management System*, U.S. Department of Energy, November 1, 2000.

30. *Homeland Security Presidential Directive (HSPD) 5*, *"Management of Domestic Incidents,"* Department of Homeland Security, February 28, 2003.

31. *Commonwealth of Virginia Emergency Operations Plan, Volume III*, Commonwealth of Virginia Radiological Emergency Response Plan, March 2002.

32. *Louisa County Radiological Emergency Response Plan*, March 2002.

33. *Caroline County Radiological Emergency Response Plan*, March 2002.

34. *Hanover County Radiological Emergency Response Plan*, March 2002.

35. *Orange County Radiological Emergency Response Plan*, March 2002.

36. *Spotsylvania County Radiological Emergency Response Plan*, March 2002.

37. *Medical College of Virginia Hospital (MCVH)/Virginia Commonwealth University (VCU) Radiation Emergency Plan*, December 5, 2000.

38. INPO 03-001, *Emergency Resources Manual*, Institute of Nuclear Power Operations, January 2003.

39. *Nuclear Power Station Emergency Preparedness Training (NPSEPT) Program Guide*, Dominion, February 2003.

40. *North Anna Nuclear Power Station Estimation of Evacuation Times*, PRC Voorhees (company formed by 1967 merger of Planning Research Corporation and Alan M. Voorhees & Associates), March 1981.

41. *Population and Evacuation Study,* Virginia Polytechnic Institute and State University Center for Transportation Research, April 6, 1990 with update dated December 10, 1991.

42. *Evacuation Time Estimates for the North Anna Power Station and Surrounding Jurisdictions*, Innovative Emergency Management, Incorporated, November 2, 2001.

43. EPPOS1, *Acceptable Deviations From Appendix 1 of NUREG-0654 Based Upon the Staff's Regulatory Analysis Of NUMARC/NESP-007, "Methodology For Development of Emergency Action Levels," Emergency Preparedness Position*, U.S. Nuclear Regulatory Commission, June 5, 1995.

44. Letter from Julius W. Becton, Jr., Director, (U.S.) Federal Emergency Management Agency, to The Honorable Gerald L. Baliles, Governor, Commonwealth of Virginia, September 2, 1987.

45. Dominion Home Page (www.dom.com)

13.6 Industrial Security

The development area for the new units is west of and adjacent to the existing units on the NAPS site. The protected area of the existing units would be extended to encompass the new units.

Like the existing units, physical protection of the new units would be based on controlling access to the NAPS site and the new units, screening operating personnel, monitoring security equipment, designing and arranging station features, and obtaining assistance from local law enforcement personnel.

The characteristics of the ESP site are such that implementation of the applicable requirements of 10 CFR 73.55 and RG 4.7, as well as the post-9/11 NRC Orders can be met. The NAPS site is sufficiently large to provide adequate distances between structures and the probable location of a security boundary.

The ESP site is located on the shore of Lake Anna. For the existing units, Virginia Power has a security program in place in compliance with the NRC Order for Interim Compensatory Measures dated February 25, 2002 that addresses waterborne threats to the site without the need to restrict access to the lake. In the event that new units are added to the site, it is anticipated that those requirements would continue to be met.

The final design of the new units power block and supporting buildings would utilize design features as appropriate to assure that the existing security distances outlined in the regulations above as well as the Design Basis Threat and any Interim Compensatory measures that may apply are adequate. The COL application would address the specific design features to assure site security as well as include the design of security monitoring equipment and methods to screen station operating personnel.

There are no security hazards in the vicinity. The ESP site is located in Louisa County in the Commonwealth of Virginia. A written agreement with Louisa County is currently in place to establish a single point of contact for police response to the NAPS site. Louisa County has mutual aid agreements in place if necessary. Auxiliary agreements also exist with other neighboring jurisdictions to provide support during station emergencies.

Chapter 15 Accident Analyses

15.1 Selection of Accidents

The radiological consequences of accidents are assessed to demonstrate that new units could be sited at the ESP site without undue risk to the health and safety of the public. The assessment uses site-specific accident meteorology with the radiological analyses in selected reactor designs to analyze the suitability of the ESP site. The assessment uses a robust and conservative set of surrogate DBAs that is representative of the range of reactor designs being considered for the ESP site. The DBAs include a spectrum of events, including those of relatively greater probability of occurrence as well as those that are less probable but have greater severity.

The set of accidents selected focuses on three light water reactor (LWR) designs: AP1000, ABWR, and ESBWR. These three designs have been chosen because these are standard designs that have recognized bases for postulated accident analyses. The accidents for some of the newer reactor types being considered are not as well defined as those for these LWRs and, hence, the accepted analytical methodologies and assumptions applied to LWRs may not apply to these newer reactors. However, because of their greater potential for inherent safety, the accident radiological consequences of the other reactors being considered for the site are expected to be bounded by the AP1000, the ABWR, and the ESBWR. If one of these other designs is eventually selected for the ESP site, the COL application would either verify that the AP1000, the ABWR, and the ESBWR doses are bounding or provide a complete evaluation of accident radiological consequences compared with regulatory limits.

The following LWR accidents are identified in the SRP, NUREG-0800 (Reference 1), as those that should be considered for radiological consequences:

- SRP Section 15.1.5, PWR Main Steam Line Break
- SRP Section 15.2.8, Feedwater System Pipe Break
- SRP Section 15.3.3, Locked Rotor Accident
- SRP Section 15.3.4, Reactor Coolant Pump Shaft Break
- SRP Section 15.4.8, PWR Rod Ejection Accident
- SRP Section 15.4.9, BWR Control Rod Drop Accident
- SRP Section 15.6.2, Failure of Small Lines Carrying Primary Coolant Outside Containment
- SRP Section 15.6.3, PWR Steam Generator Tube Failure
- SRP Section 15.6.4, BWR Main Steam Line Break
- SRP Section 15.6.5, Loss-of-Coolant Accident
- SRP Section 15.7.4, Fuel Handling Accident

RG 1.183 (Reference 2) includes a subset of these accidents. In addition, a cleanup water line break is evaluated for the ABWR and the ESBWR.

The radiological consequences from the above DBAs are analyzed. This set of accidents provides a reasonable basis for evaluating the suitability of the ESP site.

Section 15.1 References

1. NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,* NRC, 1987.

2. Regulatory Guide 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,* NRC, July 2000.

15.2 Evaluation Methodology

Doses for the representative DBAs are evaluated at the EAB and the LPZ. These doses must meet the site acceptance criteria provided in 10 CFR 50.34 and 10 CFR 100 (Reference 1 and Reference 2, respectively). Although the emergency safety features are expected to prevent core damage and mitigate releases of radioactivity, the loss-of-coolant accidents (LOCAs) analyzed presume substantial meltdowns of the core with the release of significant amounts of fission products. The postulated LOCAs are expected to more closely approach 10 CFR 50.34 limits than the other DBAs of greater probability of occurrence but lesser magnitude of activity releases. For these accidents, the calculated doses are compared to the acceptance criteria in RG 1.183 and NUREG-0800, to demonstrate that the consequences of the postulated accidents are acceptable.

The evaluations use short-term accident atmospheric dispersion factors (χ/Q). The χ/Qs are calculated using the methodology of RG 1.145 (Reference 3) and site-specific meteorological data. The following site-specific χ/Q values from Section 2.3.4.2 are used in these evaluations:

Site-Specific χ/Q Values

	χ/Q (sec/m^3)	
Time	**EAB**	**LPZ**
0–2 hr	2.26E-4	-
0–8 hr	-	2.05E-5
8–24 hr	-	1.36E-5
24–96 hr	-	5.58E-6
96–720 hr	-	1.55E-6

The accident doses are expressed as total effective dose equivalent (TEDE), consistent with 10 CFR 50.34. The TEDE consists of the sum of the committed effective dose equivalent (CEDE) from inhalation and either the deep dose equivalent (DDE) or the effective dose equivalent (EDE) from external exposure. The CEDE is determined using the dose conversion factors in Federal Guidance Report 11 (Reference 4), while the DDE and the EDE are based on dose conversion factors in Federal Guidance Report 12 (Reference 5).

Section 15.2 References

1. 10 CFR 50.34, Code of Federal Regulations, *Contents of Applications; Technical Information.*

2. 10 CFR 100, Code of Federal Regulations, *Reactor Site Criteria.*

3. Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*, Revision 1, NRC, November 1982.

4. Federal Guidance Report 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,* U. S. Environmental Protection Agency, EPA-520/1-88-020, 1988.

5. Federal Guidance Report 12, *External Exposure to Radionuclides in Air, Water, and Soil,* U. S. Environmental Protection Agency, EPA-402-R-93-081, 1993.

6. TID-14844, *Calculation of Distance Factors for Power and Test Reactor Sites,* U. S. Atomic Energy Commission, March 1962.

15.3 Source Terms

Doses are calculated based on the time-dependent activities released to the environment during each DBA. The activities are based on the analyses used to support the reactor standard safety analysis reports. Different reactor technologies use different source terms and approaches in defining the activity releases. The ABWR source term is based on TID-14844 (Reference 1). Environmental releases are calculated using the guidance in NUREG-0800 and RGs 1.3 and 1.25 (Reference 2 and Reference 3, respectively). The AP1000 and ESBWR source terms, methodologies, and assumptions are based on the alternative source term methods outlined in RG 1.183. The activity releases and doses for the AP1000, the ABWR, and the ESBWR are based on 102 percent of core thermal power.

The ABWR activity releases are scaled up from a power level of 4005 MWt (102 percent of 3926 MWt, as specified in the design certification) to 4386 MWt (102 percent of 4300 MWt, the power proposed for a new ABWR unit at the ESP site), an adjustment factor of 1.10. As the ESBWR design has not yet been certified by the NRC, the ESBWR design control document activity releases are increased by 25 percent to allow for uncertainty.

The IRIS and ACR-700 source term information are preliminary, but the AP1000 LOCA is expected to bound the worst-case accident release for these advanced reactor concepts. The advanced gas reactor designs (GT-MHR and PBMR) use mechanistic accident source terms and postulate relatively small environmental releases, compared with the water reactor technologies. The activity releases to the environment are typically provided by the reactor vendors as part of their standard design packages.

Section 15.3 References

1. TID-14844, *Calculation of Distance Factors for Power and Test Reactor Sites,* U. S. Atomic Energy Commission, March 1962.

2. Regulatory Guide 1.3, *Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors,* Revision 2, NRC, June 1974.

3. Regulatory Guide 1.25 (Safety Guide 25), *Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors,* NRC, March 1972.

15.4 Radiological Consequences

For the AP1000 and ABWR accidents identified in Section 15.1, site-specific doses are calculated by multiplying the design certification doses by the ratio of the site χ/Qs to design certification χ/Qs. The following design certification χ/Qs are used (Reference 1) (Reference 2):

Design Certification χ/Q Values and Ratios to Site χ/Q Values

		χ/Q (sec/m^3)		Ratio (Site/DC)	
	Time (hr)	**AP1000**	**ABWR**	**AP1000**	**ABWR**
EAB	0–2	6.00E-04	1.37E-03	3.77E-01	1.65E-01
LPZ	0–8	1.35E-04	1.56E-04	1.52E-01	1.31E-01
	8–24	1.00E-04	9.61E-05	1.36E-01	1.42E-01
	24–96	5.40E-05	3.36E-05	1.03E-01	1.66E-01
	96–720	2.20E-05	7.42E-06	7.05E-02	2.09E-01

Details about the methodology and assumptions pertaining to each of the accidents, such as activity release paths and the credited mitigation features, may be found in the design certification documents for the AP1000 (Reference 1), the ABWR (Reference 2), and the ESBWR (Reference 3).

As the ABWR design certification document presents whole body and thyroid doses, an equivalent TEDE value is estimated by multiplying the thyroid dose by 0.03 and adding the product to the whole body dose, in accordance with RG 1.183. Also, consistent with the activity releases in Section 15.3, the ABWR doses are scaled up by a factor of 1.10 from a power level of 4005 MWt (102 percent of 3926 MWt, as specified in the design certification) to 4386 MWt (102 percent of 4300 MWt, the power proposed for a new ABWR unit at the ESP site).

As the ESBWR design has not yet been certified by the NRC, the doses are calculated based on activity releases, which include a margin of 25 percent to allow for uncertainty. The TEDE dose from an isotope for a given time period is calculated by adding the CEDE from inhalation and the EDE from external exposure. The CEDE is calculated by multiplying the isotopic activity by the site χ/Q value, the breathing rate of the individual located offsite, and the effective inhalation dose conversion factor from Federal Guidance Report 11. The EDE is calculated by multiplying the isotopic activity by the site χ/Q value and the effective submersion dose conversion factor from Federal Guidance Report 12.

A summary of the resulting accident doses is presented in Table 15.4-1. This table also compares the accident doses to the recommended limits in RG 1.183 and NUREG-0800 and shows that the evaluated dose consequences are within the recommended limits.

The TEDE dose limits in Table 15.4-1 are taken from RG 1.183, Table 6, for all accidents except PWR Reactor Coolant Pump Shaft Break (SRP Section 15.3.4) and Failure of Small Lines Carrying Primary Coolant Outside Containment (SRP Section 15.6.2). For these two accidents, NUREG-0800 indicates that the dose limit is a “small fraction” or 10 percent of the 10 CFR 100 guideline of 25 Rem, meaning a limit of 2.5 Rem.

The doses summarized in Table 15.4-1 are based on the time-dependent doses presented in Table 15.4-2 to Table 15.4-31 for each of the accidents. In addition to doses, the latter tables show the activities released to the environment.

Section 15.4 References

1. AP1000 Document No. APP-GW-GL-700, AP1000 Design Control Document, Tier 2 Material, Westinghouse, Revision 2, 2002.
2. Document 23A6100, *ABWR Standard Safety Analysis Report,* General Electric, Revision 8.
3. Document 26A6642, ESBWR Design Control Document, Tier 2 Material, General Electric, Revision 1.

Table 15.4-1 Summary of Design Basis Accident Doses

SRP Section	Accident	Reactor	TEDE (Rem) EAB	TEDE (Rem) LPZ	TEDE (Rem) Limit
15.1.5	PWR Main Steam Line Break				
	Pre-Existing Iodine Spike	AP1000	2.6E-01	6.1E-02	25
	Accident-Initiated Iodine Spike	AP1000	3.0E-01	2.2E-01	2.5
15.2.8	Feedwater System Pipe Break	AP1000	See Note 1		2.5
		ABWR	See Note 2		2.5
		ESBWR	4.6E-05	4.2E-06	2.5
15.3.3	Reactor Coolant Pump Rotor Seizure (Locked Rotor Accident)	AP1000	9.4E-01	9.1E-02	2.5
		ABWR/ESBWR	Not Postulated		2.5
15.3.4	Reactor Coolant Pump Shaft Break	AP1000	See Note 3		2.5
		ABWR/ESBWR	Not Postulated		2.5
15.4.8	PWR Rod Ejection Accident	AP1000	1.1E+00	2.5E-01	6.3
15.4.9	BWR Control Rod Drop Accident	ABWR/ESBWR	Not Postulated		6.3
15.6.2	Failure of Small Lines Carrying Primary Coolant Outside Containment	AP1000	4.9E-01	4.6E-02	2.5
		ABWR	4.3E-02	3.9E-03	2.5
		ESBWR	3.0E-02	6.5E-03	2.5
15.6.3	PWR Steam Generator Tube Rupture				
	Pre-Existing Iodine Spike	AP1000	1.1E+00	5.2E-02	25
	Accident-Initiated Iodine Spike	AP1000	5.7E-01	3.7E-02	2.5
15.6.4	BWR Main Steam Line Break				
	Pre-Existing Iodine Spike	ABWR	5.1E-01	4.6E-02	25
	Equilibrium Iodine Activity	ABWR	2.5E-02	2.3E-03	2.5
	Pre-Existing Iodine Spike	ESBWR	2.1E+00	1.9E-01	25
	Equilibrium Iodine Activity	ESBWR	1.1E-01	9.6E-03	2.5
15.6.5	Loss-of-Coolant Accident	AP1000	9.3E+00	1.5E+00	25
		ABWR	1.8E+00	2.1E+00	25
		ESBWR	1.4E+00	9.1E-01	25

Table 15.4-1 Summary of Design Basis Accident Doses

SRP Section	Accident	Reactor	TEDE (Rem) EAB	TEDE (Rem) LPZ	TEDE (Rem) Limit
15.7.4	Fuel Handling Accident	AP1000	9.0E-01	9.1E-02	6.3
		ABWR	6.2E-01	5.7E-02	6.3
		ESBWR	1.2E+00	1.1E-01	6.3
	Cleanup Water Line Break	ABWR	3.2E-03	2.9E-04	2.5
		ESBWR	1.8E-01	1.6E-02	2.5

Note:

1. The AP1000 design certification indicates that the doses for the feedwater system pipe break are bounded by the main steam line break (Reference 1, Section 15.2.8.3).
2. The ABWR design certification indicates that the doses for the feedwater system pipe break are bounded by the cleanup water line break (Reference 2, Section 15.2.8).
3. The AP1000 design certification indicates that the doses for the reactor coolant pump shaft break are bounded by the reactor coolant pump rotor seizure (Reference 1, Section 15.3.4.2).
4. The ABWR design certification indicates that there are no radiological consequences for the reactor coolant pump rotor seizure, the reactor coolant pump shaft break, and the control rod drop accident (Reference 2, Sections 15.3.3.5, 15.3.4.5, and 15.4.10.6).
5. The ESBWR design certification indicates that there are no radiological consequences for the reactor coolant pump rotor seizure, the reactor coolant pump shaft break, and the control rod drop accident (Reference 3).

Table 15.4-2 Activity Releases for AP1000 Main Steam Line Break, Pre-Existing Iodine Spike

	Activity Release (Ci)				
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–72 hr**	**Total**
Kr-85m	2.30E-01	3.82E-01	2.26E-01	2.03E-02	8.58E-01
Kr-85	9.47E-01	2.83E+00	7.47E+00	2.17E+01	3.29E+01
Kr-87	9.24E-02	4.49E-02	1.76E-03	2.84E-07	1.39E-01
Kr-88	3.77E-01	4.59E-01	1.34E-01	2.72E-03	9.73E-01
Xe-131m	4.28E-01	1.27E+00	3.26E+00	8.78E+00	1.37E+01
Xe-133m	5.31E-01	1.51E+00	3.45E+00	6.69E+00	1.22E+01
Xe-133	3.95E+01	1.15E+02	2.87E+02	7.03E+02	1.14E+03
Xe-135m	1.02E-02	4.44E-05	0.00E+00	0.00E+00	1.02E-02
Xe-135	1.04E+00	2.31E+00	2.78E+00	1.11E+00	7.24E+00
Xe-138	1.34E-02	3.81E-05	0.00E+00	0.00E+00	1.34E-02
I-130	4.98E-01	4.74E-01	6.95E-01	4.36E-01	2.10E+00
I-131	3.37E+01	4.05E+01	1.03E+02	2.67E+02	4.44E+02
I-132	4.02E+01	1.39E+01	2.68E+00	2.16E-02	5.68E+01
I-133	6.03E+01	6.35E+01	1.17E+02	1.30E+02	3.71E+02
I-134	8.24E+00	5.47E-01	4.77E-03	1.50E-08	8.79E+00
I-135	3.56E+01	2.73E+01	2.51E+01	5.60E+00	9.36E+01
Cs-134	1.91E+01	6.52E-01	1.72E+00	5.00E+00	2.65E+01
Cs-136	2.84E+01	9.57E-01	2.47E+00	6.69E+00	3.85E+01
Cs-137	1.38E+01	4.70E-01	1.24E+00	3.61E+00	1.91E+01
Cs-138	1.02E+01	3.41E-03	1.48E-06	0.00E+00	1.02E+01
Total	2.93E+02	2.72E+02	5.58E+02	1.16E+03	2.28E+03

Table 15.4-3 Doses for AP1000 Main Steam Line Break, Pre-Existing Iodine Spike

	AP1000 TEDE (Rem)		χ/Q Ratio	Site TEDE (Rem)	
Time	**EAB**	**LPZ**	**(Site/AP1000)**	**EAB**	**LPZ**
0–2 hr	7.00E-01		3.77E-01	2.64E-01	
0–8 hr		2.40E-01	1.52E-01		3.64E-02
8–24 hr		8.00E-02	1.36E-01		1.09E-02
24–96 hr		1.30E-01	1.03E-01		1.34E-02
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	7.00E-01	4.50E-01		2.64E-01	6.08E-02
Limit				25	25

Table 15.4-4 Activity Releases for AP1000 Main Steam Line Break, Accident-Initiated Iodine Spike

	Activity Release (Ci)				
Isotope	0–2 hr	2–8 hr	8–24 hr	24–72 hr	Total
Kr-85m	2.30E-01	3.82E-01	2.26E-01	2.03E-02	8.58E-01
Kr-85	9.47E-01	2.83E+00	7.47E+00	2.17E+01	3.29E+01
Kr-87	9.24E-02	4.49E-02	1.76E-03	2.84E-07	1.39E-01
Kr-88	3.77E-01	4.59E-01	1.34E-01	2.72E-03	9.73E-01
Xe-131m	4.28E-01	1.27E+00	3.26E+00	8.78E+00	1.37E+01
Xe-133m	5.31E-01	1.51E+00	3.45E+00	6.69E+00	1.22E+01
Xe-133	3.95E+01	1.15E+02	2.87E+02	7.03E+02	1.14E+03
Xe-135m	1.02E-02	4.44E-05	0.00E+00	0.00E+00	1.02E-02
Xe-135	1.04E+00	2.31E+00	2.78E+00	1.11E+00	7.24E+00
Xe-138	1.34E-02	3.81E-05	0.00E+00	0.00E+00	1.34E-02
I-130	6.84E-01	3.33E+00	5.27E+00	3.30E+00	1.26E+01
I-131	3.92E+01	1.92E+02	5.18E+02	1.35E+03	2.10E+03
I-132	9.12E+01	3.26E+02	7.46E+01	6.00E-01	4.92E+02
I-133	7.75E+01	3.81E+02	7.54E+02	8.34E+02	2.05E+03
I-134	3.03E+01	6.23E+01	8.85E-01	2.78E-06	9.35E+01
I-135	5.57E+01	2.59E+02	2.61E+02	5.82E+01	6.34E+02
Cs-134	1.91E+01	6.52E-01	1.72E+00	5.00E+00	2.65E+01
Cs-136	2.84E+01	9.57E-01	2.47E+00	6.69E+00	3.85E+01
Cs-137	1.38E+01	4.70E-01	1.24E+00	3.61E+00	1.91E+01
Cs-138	1.02E+01	3.41E-03	1.48E-06	0.00E+00	1.02E+01
Total	4.09E+02	1.35E+03	1.92E+03	3.00E+03	6.68E+03

Table 15.4-5 Doses for AP1000 Main Steam Line Break, Accident-Initiated Iodine Spike

Time	AP1000 TEDE (Rem) EAB	AP1000 TEDE (Rem) LPZ	χ/Q Ratio (Site/AP1000)	Site TEDE (Rem) EAB	Site TEDE (Rem) LPZ
0–2 hr	8.00E-01		3.77E-01	3.01E-01	
0–8 hr		6.40E-01	1.52E-01		9.72E-02
8–24 hr		4.20E-01	1.36E-01		5.71E-02
24–96 hr		6.30E-01	1.03E-01		6.51E-02
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	8.00E-01	1.69E+00		3.01E-01	2.19E-01
Limit				2.5	2.5

Table 15.4-5a Activity Releases for ABWR Cleanup Water Line Break

Isotope	Activity Release (Ci) 0–2 hr
I-131	2.40E+00
I-132	5.62E+00
I-133	6.80E+00
I-134	9.46E+00
I-135	7.39E+00
Total	3.17E+01

Table 15.4-5b Doses for ABWR Cleanup Water Line Break

	ABWR EAB Dose (S_v)			χ/Q Ratio	Site TEDE (Rem)	
Time	**W. Body**	**Thyroid**	**TEDE**	**(Site/ABWR)**	**EAB**	**LPZ**
0–2 hr	1.70E-04	1.70E-04	1.75E-04	1.65E-01	3.16E-03	
0–8 hr	1.70E-04	1.70E-04	1.75E-04	1.50E-02		2.87E-04
8–24 hr						0.00E+00
24–96 hr						0.00E+00
96–720 hr						0.00E+00
Total	1.70E-04	1.70E-04	1.75E-04		3.16E-03	2.87E-04
Limit					2.5	2.5

Note: The ABWR TEDE is whole body dose plus 3% of thyroid dose. Since the ABWR design certification document does not include an LPZ dose for this accident, the site LPZ dose is obtained by multiplying the ABWR EAB dose by the ratio of site LPZ χ/Q to ABWR EAB χ/Q. The site doses include a multiplier of 1.10 for power adjustment.

Table 15.4-5c Activity Releases for ESBWR Feedwater System Pipe Break

	Activity Release (Ci)
Isotope	**0–2 hr**
I-131	4.39E-03
I-132	4.05E-02
I-133	2.94E-02
I-134	7.43E-02
I-135	4.05E-02
Total	1.89E-01

Table 15.4-5d Doses for ESBWR Feedwater System Pipe Break

	Site TEDE (Rem)	
Time	EAB	LPZ
0–2 hr	4.63E-05	
0–8 hr		4.20E-06
8–24 hr		0.00E+00
24–96 hr		0.00E+00
96–720 hr		0.00E+00
Total	4.63E-05	4.20E-06
Limit	2.5	2.5

Table 15.4-6 Activity Releases for AP1000 Locked Rotor Accident

Isotope	Activity Release (Ci) 0–2 hr
Kr-85m	4.09E+02
Kr-85	3.77E+01
Kr-87	6.05E+02
Kr-88	1.05E+03
Xe-131m	1.87E+01
Xe-133m	1.02E+02
Xe-133	3.33E+03
Xe-135m	1.63E+02
Xe-135	8.01E+02
Xe-138	6.48E+02
I-130	4.15E+00
I-131	1.83E+02
I-132	1.33E+02
I-133	2.31E+02
I-134	1.44E+02
I-135	2.04E+02
Cs-134	5.83E+00
Cs-136	1.85E+00
Cs-137	3.42E+00
Cs-138	3.05E+01
Rb-86	6.69E-02
Total	8.11E+03

Table 15.4-7 Doses for AP1000 Locked Rotor Accident

Time	AP1000 TEDE (Rem)		χ/Q Ratio (Site/AP1000)	Site TEDE (Rem)	
	EAB	LPZ		EAB	LPZ
0–2 hr	2.50E+00		3.77E-01	9.42E-01	
0–8 hr		6.00E-01	1.52E-01		9.11E-02
8–24 hr		0.00E+00	1.36E-01		0.00E+00
24–96 hr		0.00E+00	1.03E-01		0.00E+00
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	2.50E+00	6.00E-01		9.42E-01	9.11E-02
Limit				2.5	2.5

Table 15.4-8 Activity Releases for AP1000 Rod Ejection Accident

	Activity Release (Ci)					
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–96 hr**	**96–720 hr**	**Total**
Kr-85m	2.85E+02	6.48E+01	3.87E+01	3.53E+00	5.01E-05	3.92E+02
Kr-85	1.24E+01	5.60E+00	1.49E+01	6.70E+01	5.71E+02	6.71E+02
Kr-87	4.86E+02	2.60E+01	1.03E+00	1.67E-04	0.00E+00	5.13E+02
Kr-88	7.49E+02	1.18E+02	3.49E+01	7.18E-01	1.68E-08	9.03E+02
Xe-131m	1.22E+01	5.46E+00	1.42E+01	5.72E+01	2.31E+02	3.20E+02
Xe-133m	6.62E+01	2.81E+01	6.49E+01	1.69E+02	1.06E+02	4.34E+02
Xe-133	2.18E+03	9.58E+02	2.40E+03	8.53E+03	1.68E+04	3.09E+04
Xe-135m	2.18E+02	5.30E-02	4.33E-09	0.00E+00	0.00E+00	2.18E+02
Xe-135	5.39E+02	1.72E+02	2.09E+02	8.69E+01	3.58E-01	1.01E+03
Xe-138	8.89E+02	1.38E-01	3.19E-09	0.00E+00	0.00E+00	8.89E+02
I-130	5.93E+00	7.28E+00	4.32E+00	4.06E-01	5.88E-04	1.79E+01
I-131	1.64E+02	2.45E+02	2.31E+02	6.20E+01	3.33E+01	7.35E+02
I-132	1.90E+02	9.94E+01	9.85E+00	1.65E-02	0.00E+00	2.99E+02
I-133	3.29E+02	4.40E+02	3.18E+02	4.56E+01	4.81E-01	1.13E+03
I-134	2.18E+02	2.85E+01	1.37E-01	8.96E-08	0.00E+00	2.47E+02
I-135	2.91E+02	2.97E+02	1.19E+02	4.79E+00	1.46E-04	7.12E+02
Cs-134	3.15E+01	6.22E+01	6.03E+01	1.55E+01	1.03E+01	1.80E+02
Cs-136	8.98E+00	1.75E+01	1.67E+01	4.10E+00	1.31E+00	4.86E+01
Cs-137	1.83E+01	3.62E+01	3.51E+01	9.04E+00	6.05E+00	1.05E+02
Cs-138	1.13E+02	7.05E+00	1.68E-03	0.00E+00	0.00E+00	1.20E+02
Rb-86	3.70E-01	7.27E-01	6.96E-01	1.73E-01	6.79E-02	2.03E+00
Total	6.81E+03	2.62E+03	3.57E+03	9.06E+03	1.78E+04	3.98E+04

Table 15.4-9 Doses for AP1000 Rod Ejection Accident

Time	AP1000 TEDE (Rem)		χ/Q Ratio (Site/AP1000)	Site TEDE (Rem)	
	EAB	LPZ		EAB	LPZ
0–2 hr	3.00E+00		3.77E-01	1.13E+00	
0–8 hr		1.40E+00	1.52E-01		2.13E-01
8–24 hr		2.60E-01	1.36E-01		3.54E-02
24–96 hr		4.60E-02	1.03E-01		4.75E-03
96–720 hr		1.20E-02	7.05E-02		8.45E-04
Total	3.00E+00	1.72E+00		1.13E+00	2.54E-01
Limit				6.3	6.3

Table 15.4-10 Doses for AP1000 Failure of Small Lines Carrying Primary Coolant Outside Containment

Time	AP1000 TEDE (Rem)		χ/Q Ratio (Site/AP1000)	Site TEDE (Rem)	
	EAB	LPZ		EAB	LPZ
0–2 hr	1.30E+00		3.77E-01	4.90E-01	
0–8 hr		3.00E-01	1.52E-01		4.56E-02
8–24 hr		0.00E+00	1.36E-01		0.00E+00
24–96 hr		0.00E+00	1.03E-01		0.00E+00
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	1.30E+00	3.00E-01		4.90E-01	4.56E-02
Limit				2.5	2.5

Note: No activity release information is available for this accident.

Table 15.4-11 Activity Releases for ABWR Failure of Small Lines Carrying Primary Coolant Outside Containment

	Activity Release (Ci)		
Isotope	**0–2 hr**	**2–8 hr**	**Total**
I-131	2.01E+00	2.16E+00	4.17E+00
I-132	1.76E+01	1.76E+01	3.52E+01
I-133	1.36E+01	1.43E+01	2.79E+01
I-134	2.93E+01	2.69E+01	5.62E+01
I-135	1.95E+01	2.01E+01	3.96E+01
Total	8.20E+01	8.11E+01	1.63E+02

Table 15.4-12 Doses for ABWR Failure of Small Lines Carrying Primary Coolant Outside Containment

	ABWR EAB Dose (S_v)			χ/Q Ratio	Site TEDE (Rem)	
Time	**W. Body**	**Thyroid**	**TEDE**	**(Site/ABWR)**	**EAB**	**LPZ**
0–2 hr	9.40E-04	4.80E-02	2.38E-03	1.65E-01	4.30E-02	
0–8 hr	9.40E-04	4.80E-02	2.38E-03	1.50E-02		3.90E-03
8–24 hr						0.00E+00
24–96 hr						0.00E+00
96–720 hr						0.00E+00
Total	9.40E-04	4.80E-02	2.38E-03		4.30E-02	3.90E-03
Limit					2.5	2.5

Note: The ABWR TEDE is whole body dose plus 3% of thyroid dose. Since the ABWR design certification document does not include an LPZ dose for this accident, the site LPZ dose is obtained by multiplying the ABWR EAB dose by ratio of site LPZ χ/Q to ABWR EAB χ/Q. The site doses include a multiplier of 1.10 for power adjustment.

Table 15.4-12a Activity Releases for ESBWR Failure of Small Lines Carrying Primary Coolant Outside Containment

	Activity Release (Ci)		
Isotope	**0–2 hr**	**2–8 hr**	**Total**
I-131	6.13E+00	1.05E+01	1.66E+01
I-132	8.03E+00	7.35E+00	1.54E+01
I-133	1.51E+01	2.35E+01	3.86E+01
I-134	8.78E+00	4.60E+00	1.34E+01
I-135	1.39E+01	1.85E+01	3.24E+01
Total	5.19E+01	6.45E+01	1.16E+02

Table 15.4-12b Doses for ESBWR Failure of Small Lines Carrying Primary Coolant Outside Containment

	Site TEDE (Rem)	
Time	**EAB**	**LPZ**
2–4 hr	3.04E-02	
0–8 hr		6.46E-03
8–24 hr		0.00E+00
24–96 hr		0.00E+00
96–720 hr		0.00E+00
Total	3.04E-02	6.46E-03
Limit	2.5	2.5

Note: The maximum EAB dose occurs between 2 and 4 hours, and it is calculated based on the χ/Q between 0 and 2 hours.

Table 15.4-13 Activity Releases for AP1000 Steam Generator Tube Rupture, Pre-Existing Iodine Spike

	Activity Release (Ci)			
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**Total**
Kr-85m	5.67E+01	1.91E+01	2.50E-02	7.58E+01
Kr-85	2.25E+02	1.07E+02	4.44E-01	3.32E+02
Kr-87	2.46E+01	3.56E+00	3.02E-04	2.82E+01
Kr-88	9.44E+01	2.61E+01	1.80E-02	1.21E+02
Xe-131m	1.02E+02	4.82E+01	1.96E-01	1.50E+02
Xe-133m	1.26E+02	5.83E+01	2.19E-01	1.85E+02
Xe-133	9.37E+03	4.41E+03	1.75E+01	1.38E+04
Xe-135m	3.61E+00	5.78E-03	0.00E+00	3.62E+00
Xe-135	2.51E+02	1.00E+02	2.35E-01	3.51E+02
Xe-138	4.78E+00	4.99E-03	0.00E+00	4.78E+00
I-130	1.81E+00	6.12E-02	2.90E-01	2.16E+00
I-131	1.22E+02	5.97E+00	3.32E+01	1.61E+02
I-132	1.43E+02	8.53E-01	2.08E+00	1.46E+02
I-133	2.19E+02	8.68E+00	4.41E+01	2.72E+02
I-134	2.78E+01	5.16E-03	4.57E-03	2.78E+01
I-135	1.28E+02	3.06E+00	1.26E+01	1.44E+02
Cs-134	1.65E+00	6.35E-02	2.27E-01	1.94E+00
Cs-136	2.45E+00	9.30E-02	3.30E-01	2.87E+00
Cs-137	1.19E+00	4.58E-02	1.64E-01	1.40E+00
Cs-138	5.71E-01	3.07E-06	6.00E-07	5.71E-01
Total	1.09E+04	4.79E+03	1.12E+02	1.58E+04

Table 15.4-14 Doses for AP1000 Steam Generator Tube Rupture, Pre-Existing Iodine Spike

	AP1000 TEDE (Rem)		χ/Q Ratio	Site TEDE (Rem)	
Time	EAB	LPZ	(Site/AP1000)	EAB	LPZ
0–2 hr	3.00E+00		3.77E-01	1.13E+00	
0–8 hr		3.20E-01	1.52E-01		4.86E-02
8–24 hr		2.60E-02	1.36E-01		3.54E-03
24–96 hr		0.00E+00	1.03E-01		0.00E+00
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	3.00E+00	3.46E-01		1.13E+00	5.21E-02
Limit				25	25

Table 15.4-15 Activity Releases for AP1000 Steam Generator Tube Rupture, Accident-Initiated Iodine Spike

	Activity Release (Ci)			
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**Total**
Kr-85m	5.67E+01	1.91E+01	2.50E-02	7.58E+01
Kr-85	2.25E+02	1.07E+02	4.44E-01	3.32E+02
Kr-87	2.46E+01	3.56E+00	3.02E-04	2.82E+01
Kr-88	9.44E+01	2.61E+01	1.80E-02	1.21E+02
Xe-131m	1.02E+02	4.82E+01	1.96E-01	1.50E+02
Xe-133m	1.26E+02	5.83E+01	2.19E-01	1.85E+02
Xe-133	9.37E+03	4.41E+03	1.75E+01	1.38E+04
Xe-135m	3.61E+00	5.78E-03	0.00E+00	3.62E+00
Xe-135	2.51E+02	1.00E+02	2.35E-01	3.51E+02
Xe-138	4.78E+00	4.99E-03	0.00E+00	4.78E+00
I-130	7.30E-02	1.19E-02	3.13E-02	1.16E-01
I-131	4.90E+00	1.15E+00	3.55E+00	9.60E+00
I-132	5.79E+00	1.75E-01	2.30E-01	6.20E+00
I-133	8.79E+00	1.68E+00	4.73E+00	1.52E+01
I-134	1.12E+00	1.18E-03	5.21E-04	1.12E+00
I-135	5.15E+00	6.01E-01	1.36E+00	7.11E+00
Cs-134	1.65E+00	6.35E-02	2.27E-01	1.94E+00
Cs-136	2.45E+00	9.30E-02	3.30E-01	2.87E+00
Cs-137	1.19E+00	4.58E-02	1.64E-01	1.40E+00
Cs-138	5.71E-01	3.07E-06	6.00E-07	5.71E-01
Total	1.03E+04	4.78E+03	2.93E+01	1.51E+04

Table 15.4-16 Doses for AP1000 Steam Generator Tube Rupture, Accident-Initiated Iodine Spike

	AP1000 TEDE (Rem)		χ/Q Ratio	Site TEDE (Rem)	
Time	EAB	LPZ	(Site/AP1000)	EAB	LPZ
0–2 hr	1.50E+00		3.77E-01	5.65E-01	
0–8 hr		1.80E-01	1.52E-01		2.73E-02
8–24 hr		7.20E-02	1.36E-01		9.79E-03
24–96 hr		0.00E+00	1.03E-01		0.00E+00
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	1.50E+00	2.52E-01		5.65E-01	3.71E-02
Limit				2.5	2.5

Table 15.4-17 Activity Releases for ABWR Main Steam Line Break

	Activity Release (Ci)	
Isotope	Pre-Existing	Equilibrium Activity
I-131	4.32E+01	2.16E+00
I-132	4.20E+02	2.10E+01
I-133	2.95E+02	1.48E+01
I-134	8.25E+02	4.14E+01
I-135	4.32E+02	2.16E+01
Kr-83m	7.22E-02	1.20E-02
Kr-85m	1.27E-01	2.12E-02
Kr-85	4.02E-04	6.68E-05
Kr-87	4.35E-01	7.22E-02
Kr-88	4.38E-01	7.27E-02
Kr-89	1.75E+00	2.92E-01
Kr-90	4.58E-01	7.54E-02
Xe-131m	3.13E-04	5.20E-05
Xe-133m	6.03E-03	1.00E-03
Xe-133	1.69E-01	2.80E-02
Xe-135m	5.15E-01	8.55E-02
Xe-135	4.79E-01	7.98E-02
Xe-137	2.19E+00	3.64E-01
Xe-138	1.67E+00	2.79E-01
Xe-139	7.66E-01	1.28E-01
Total	2.02E+03	1.02E+02

Table 15.4-18 Doses for ABWR Main Steam Line Break, Pre-Existing Iodine Spike

	ABWR EAB Dose (S_v)			χ/Q Ratio	Site TEDE (Rem)	
Time	**W. Body**	**Thyroid**	**TEDE**	**(Site/ABWR)**	**EAB**	**LPZ**
0–2 hr	1.30E-02	5.10E-01	2.83E-02	1.65E-01	5.11E-01	
0–8 hr	1.30E-02	5.10E-01	2.83E-02	1.50E-02		4.64E-02
8–24 hr						0.00E+00
24–96 hr						0.00E+00
96–720 hr						0.00E+00
Total	1.30E-02	5.10E-01	2.83E-02		5.11E-01	4.64E-02
Limit					25	25

Note: The ABWR TEDE is whole body dose plus 3% of thyroid dose. Since the ABWR design certification document does not include an LPZ dose for this accident, the site LPZ dose is obtained by multiplying the ABWR EAB dose by ratio of site LPZ χ/Q to ABWR EAB χ/Q. The site doses include a multiplier of 1.10 for power adjustment.

Table 15.4-19 Doses for ABWR Main Steam Line Break, Equilibrium Iodine Activity

	ABWR EAB Dose (S_v)			χ/Q Ratio	Site TEDE (Rem)	
Time	**W. Body**	**Thyroid**	**TEDE**	**(Site/ABWR)**	**EAB**	**LPZ**
0–2 hr	6.20E-04	2.60E-02	1.40E-03	1.65E-01	2.53E-02	
0–8 hr	6.20E-04	2.60E-02	1.40E-03	1.50E-02		2.29E-03
8–24 hr						0.00E+00
24–96 hr						0.00E+00
96–720 hr						0.00E+00
Total	6.20E-04	2.60E-02	1.40E-03		2.53E-02	2.29E-03
Limit					2.5	2.5

Note: The ABWR TEDE is whole body dose plus 3% of thyroid dose. Since the ABWR design certification document does not include an LPZ dose for this accident, the site LPZ dose is obtained by multiplying the ABWR EAB dose by ratio of site LPZ χ/Q to ABWR EAB χ/Q. The site doses include a multiplier of 1.10 for power adjustment.

Table 15.4-19a Activity Releases for ESBWR Main Steam Line Break

	Activity Release (Ci)	
Isotope	Pre-Existing	Equilibrium Activity
I-131	1.96E+02	9.79E+00
I-132	1.86E+03	9.45E+01
I-133	1.35E+03	6.75E+01
I-134	3.38E+03	1.72E+02
I-135	1.92E+03	9.45E+01
Kr-85m	1.72E-02	1.72E-02
Kr-85	6.75E-05	6.75E-05
Kr-87	5.74E-02	5.74E-02
Kr-88	5.74E-02	5.74E-02
Xe-133	2.46E-02	2.46E-02
Xe-135	6.75E-02	6.75E-02
Total	8.70E+03	4.39E+02

Table 15.4-19b Doses for ESBWR Main Steam Line Break, Pre-Existing Iodine Spike

	Site TEDE (Rem)	
Time	EAB	LPZ
0–2 hr	2.12E+00	
0–8 hr		1.92E-01
8–24 hr		0.00E+00
24–96 hr		0.00E+00
96–720 hr		0.00E+00
Total	2.12E+00	1.92E-01
Limit	25	25

Table 15.4-19c Doses for ESBWR Main Steam Line Break, Equilibrium Iodine Activity

	Site TEDE (Rem)	
Time	**EAB**	**LPZ**
0–2 hr	1.06E-01	
0–8 hr		9.64E-03
8–24 hr		0.00E+00
24–96 hr		0.00E+00
96–720 hr		0.00E+00
Total	1.06E-01	9.64E-03
Limit	2.5	2.5

Table 15.4-20 Activity Releases for AP1000 Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–96 hr**	**96–720 hr**	**Total**
Kr-85m	6.31E+02	3.14E+03	1.87E+03	1.71E+02	2.43E-03	5.82E+03
Kr-85	3.22E+01	2.64E+02	7.05E+02	3.17E+03	2.70E+04	3.12E+04
Kr-87	6.87E+02	1.26E+03	4.97E+01	8.11E-03	0.00E+00	1.99E+03
Kr-88	1.50E+03	5.76E+03	1.70E+03	3.49E+01	8.16E-07	8.99E+03
Xe-131m	3.20E+01	2.62E+02	6.79E+02	2.74E+03	1.11E+04	1.48E+04
Xe-133m	1.74E+02	1.37E+03	3.15E+03	8.21E+03	5.15E+03	1.80E+04
Xe-133	5.71E+03	4.62E+04	1.16E+05	4.11E+05	8.10E+05	1.39E+06
Xe-135m	3.33E+01	2.62E+00	2.14E-07	0.00E+00	0.00E+00	3.59E+01
Xe-135	1.31E+03	8.33E+03	1.01E+04	4.21E+03	1.73E+01	2.40E+04
Xe-138	1.14E+02	6.83E+00	1.58E-07	0.00E+00	0.00E+00	1.20E+02
I-130	3.22E+01	4.58E+01	2.96E+00	1.11E+00	1.99E-02	8.21E+01
I-131	9.13E+02	1.45E+03	1.56E+02	3.74E+02	1.12E+03	4.01E+03
I-132	8.77E+02	7.93E+02	7.64E+00	2.29E-02	0.00E+00	1.68E+03
I-133	1.81E+03	2.70E+03	2.16E+02	1.63E+02	1.62E+01	4.91E+03
I-134	7.16E+02	3.04E+02	1.26E-01	1.07E-07	0.00E+00	1.02E+03
I-135	1.53E+03	1.97E+03	8.31E+01	9.55E+00	4.95E-03	3.59E+03
Cs-134	1.46E+02	2.16E+02	8.06E+00	1.88E-01	1.59E+00	3.72E+02
Cs-136	4.15E+01	6.13E+01	2.25E+00	4.72E-02	2.03E-01	1.05E+02
Cs-137	8.50E+01	1.26E+02	4.70E+00	1.10E-01	9.39E-01	2.17E+02
Cs-138	2.67E+02	5.25E+01	6.92E-04	0.00E+00	0.00E+00	3.19E+02
Rb-86	1.72E+00	2.54E+00	9.37E-02	2.03E-03	1.05E-02	4.37E+00
Sb-127	1.10E+01	2.01E+01	7.13E-01	1.16E-02	1.60E-02	3.18E+01
Sb-129	2.63E+01	3.65E+01	4.83E-01	1.01E-04	1.00E-09	6.33E+01
Te-127m	1.42E+00	2.64E+00	9.83E-02	2.27E-03	1.77E-02	4.18E+00
Te-127	9.83E+00	1.59E+01	3.65E-01	5.63E-04	2.72E-06	2.61E+01
Te-129m	4.85E+00	9.00E+00	3.33E-01	7.47E-03	4.79E-02	1.42E+01
Te-129	1.35E+01	9.71E+00	8.54E-03	7.27E-10	0.00E+00	2.32E+01
Te-131m	1.46E+01	2.60E+01	8.29E-01	6.86E-03	1.60E-03	4.14E+01

Table 15.4-20 Activity Releases for AP1000 Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–96 hr**	**96–720 hr**	**Total**
Te-132	1.46E+02	2.68E+02	9.42E+00	1.44E-01	1.60E-01	4.24E+02
Sr-89	4.16E+01	7.74E+01	2.87E+00	6.54E-02	4.60E-01	1.22E+02
Sr-90	3.59E+00	6.68E+00	2.48E-01	5.82E-03	4.97E-02	1.06E+01
Sr-91	4.64E+01	7.52E+01	1.74E+00	2.76E-03	1.44E-05	1.23E+02
Sr-92	3.80E+01	4.50E+01	3.26E-01	1.06E-05	0.00E+00	8.33E+01
Ba-139	3.64E+01	2.98E+01	4.73E-02	2.03E-08	0.00E+00	6.63E+01
Ba-140	7.35E+01	1.36E+02	5.00E+00	1.05E-01	4.41E-01	2.15E+02
Mo-99	9.77E+00	1.78E+01	6.19E-01	8.79E-03	7.72E-03	2.82E+01
Tc-99m	7.30E+00	1.10E+01	1.94E-01	1.08E-04	2.73E-08	1.85E+01
Ru-103	7.82E+00	1.45E+01	5.38E-01	1.21E-02	8.11E-02	2.30E+01
Ru-105	4.19E+00	5.87E+00	7.97E-02	1.82E-05	2.40E-10	1.01E+01
Ru-106	2.57E+00	4.79E+00	1.78E-01	4.16E-03	3.46E-02	7.58E+00
Rh-105	4.71E+00	8.45E+00	2.76E-01	2.64E-03	8.48E-04	1.34E+01
Ce-141	1.76E+00	3.26E+00	1.21E-01	2.71E-03	1.72E-02	5.16E+00
Ce-143	1.59E+00	2.84E+00	9.20E-02	8.29E-04	2.34E-04	4.51E+00
Ce-144	1.32E+00	2.47E+00	9.19E-02	2.14E-03	1.77E-02	3.91E+00
Pu-238	4.13E-03	7.70E-03	2.86E-04	6.71E-06	5.73E-05	1.22E-02

Table 15.4-20 Activity Releases for AP1000 Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–96 hr**	**96–720 hr**	**Total**
Pu-239	3.63E-04	6.77E-04	2.52E-05	5.90E-07	5.04E-06	1.07E-03
Pu-240	5.34E-04	9.92E-04	3.69E-05	8.65E-07	7.39E-06	1.57E-03
Pu-241	1.19E-01	2.23E-01	8.30E-03	1.94E-04	1.66E-03	3.52E-01
Np-239	2.04E+01	3.72E+01	1.27E+00	1.67E-02	1.17E-02	5.89E+01
Y-90	3.68E-02	6.70E-02	2.32E-03	3.25E-05	2.75E-05	1.06E-01
Y-91	5.35E-01	9.94E-01	3.69E-02	8.43E-04	6.09E-03	1.57E+00
Y-92	4.18E-01	5.46E-01	5.77E-03	5.86E-07	0.00E+00	9.70E-01
Y-93	5.81E-01	9.48E-01	2.25E-02	4.05E-05	2.91E-07	1.55E+00
Nb-95	7.20E-01	1.34E+00	4.95E-02	1.11E-03	7.23E-03	2.12E+00
Zr-95	7.17E-01	1.33E+00	4.94E-02	1.13E-03	8.29E-03	2.11E+00
Zr-97	6.66E-01	1.15E+00	3.26E-02	1.38E-04	7.58E-06	1.84E+00
La-140	7.66E-01	1.38E+00	4.58E-02	4.84E-04	1.97E-04	2.19E+00
La-141	5.37E-01	7.26E-01	8.69E-03	1.31E-06	0.00E+00	1.27E+00
La-142	3.47E-01	3.06E-01	6.67E-04	6.96E-10	0.00E+00	6.53E-01
Nd-147	2.79E-01	5.16E-01	1.89E-02	3.88E-04	1.49E-03	8.16E-01
Pr-143	6.28E-01	1.16E+00	4.27E-02	9.01E-04	3.95E-03	1.84E+00
Am-241	5.40E-05	1.00E-04	3.74E-06	8.75E-08	7.48E-07	1.59E-04
Cm-242	1.27E-02	2.37E-02	8.81E-04	2.04E-05	1.64E-04	3.75E-02
Cm-244	1.56E-03	2.91E-03	1.08E-04	2.53E-06	2.16E-05	4.61E-03
Total	1.72E+04	7.52E+04	1.35E+05	4.30E+05	8.54E+05	1.51E+06

Table 15.4-21 Doses for AP1000 Loss-of-Coolant Accident

Time	AP1000 TEDE (Rem) EAB	AP1000 TEDE (Rem) LPZ	χ/Q Ratio (Site/AP1000)	Site TEDE (Rem) EAB	Site TEDE (Rem) LPZ
1–3 hr	2.48E+01		3.77E-01	9.34E+00	
0–8 hr		9.20E+00	1.52E-01		1.40E+00
8–24 hr		3.30E-01	1.36E-01		4.49E-02
24–96 hr		3.10E-01	1.03E-01		3.20E-02
96–720 hr		2.90E-01	7.05E-02		2.04E-02
Total	2.48E+01	1.01E+01		9.34E+00	1.49E+00
Limit				25	25

Note: For the EAB, the period from 1 to 3 hours yields the maximum two-hour dose.

Table 15.4-22 Activity Releases for ABWR Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–96 hr**	**96–720 hr**	**Total**
I-131	2.84E+02	1.25E+02	1.01E+03	9.52E+03	6.80E+04	7.90E+04
I-132	3.85E+02	3.63E+01	3.55E+01	0.00E+00	0.00E+00	4.57E+02
I-133	5.92E+02	2.21E+02	1.29E+03	3.64E+03	7.39E+02	6.48E+03
I-134	5.62E+02	1.17E+00	0.00E+00	0.00E+00	0.00E+00	5.63E+02
I-135	5.62E+02	1.45E+02	3.63E+02	1.83E+02	0.00E+00	1.25E+03
Kr-83m	3.57E+02	5.09E+02	1.66E+02	0.00E+00	0.00E+00	1.03E+03
Kr-85	4.47E+01	3.38E+02	2.40E+03	2.38E+04	3.13E+05	3.40E+05
Kr-85m	9.24E+02	3.17E+03	4.78E+03	7.69E+02	0.00E+00	9.64E+03
Kr-87	1.31E+03	1.07E+03	1.01E+02	0.00E+00	0.00E+00	2.48E+03
Kr-88	2.32E+03	5.48E+03	3.76E+03	3.25E+02	0.00E+00	1.19E+04
Kr-89	1.98E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.98E+02
Xe-131m	2.33E+01	1.65E+02	1.22E+03	1.04E+04	6.80E+04	7.98E+04
Xe-133	8.35E+03	5.85E+04	4.12E+05	3.04E+06	9.20E+06	1.27E+07
Xe-133m	3.28E+02	2.38E+03	1.51E+04	8.31E+04	7.95E+04	1.80E+05
Xe-135	1.01E+03	5.02E+03	1.66E+04	1.28E+04	0.00E+00	3.55E+04
Xe-135m	5.33E+02	8.87E-02	0.00E+00	0.00E+00	0.00E+00	5.33E+02
Xe-137	5.62E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E+02
Xe-138	2.19E+03	1.48E-01	0.00E+00	0.00E+00	0.00E+00	2.19E+03
Total	2.05E+04	7.72E+04	4.59E+05	3.18E+06	9.73E+06	1.35E+07

Table 15.4-23 Doses for ABWR Loss-of-Coolant Accident

	ABWR EAB Dose (S_v)			ABWR LPZ Dose (S_v)			χ/Q Ratio	Site TEDE (Rem)	
Time	W. Body	Thyroid	TEDE	W. Body	Thyroid	TEDE	(Site/ABWR)	EAB	LPZ
0–2 hr	4.10E-02	1.90E+00	9.80E-02				1.65E-01	1.77E+00	
0–8 hr				1.00E-02	3.10E-01	1.93E-02	1.31E-01		2.78E-01
8–24 hr				8.00E-03	2.00E-01	1.40E-02	1.42E-01		2.17E-01
24–96 hr				1.10E-02	7.90E-01	3.47E-02	1.66E-01		6.31E-01
96–720 hr				9.00E-03	1.10E+00	4.20E-02	2.09E-01		9.61E-01
Total	4.10E-02	1.90E+00	9.80E-02	3.80E-02	2.40E+00	1.10E-01		1.77E+00	2.09E+00
Limit								25	25

Note: The ABWR TEDE is whole body dose plus 3% of thyroid dose. The site doses include a multiplier of 1.10 for power adjustment.

Table 15.4-23a Activity Releases for ESBWR Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total
Co-58	2.28E-03	2.22E-02	3.89E-02	4.18E-02	2.61E-02	1.31E-01
Co-60	2.19E-03	2.16E-02	3.76E-02	4.10E-02	2.89E-02	1.31E-01
Kr-85	6.59E+00	3.23E+02	2.72E+03	2.08E+04	5.31E+04	7.70E+04
Kr-85m	1.14E+02	3.01E+03	5.21E+03	8.50E+02	0.00E+00	9.19E+03
Kr-87	1.17E+02	8.60E+02	1.08E+02	0.00E+00	0.00E+00	1.09E+03
Kr-88	2.68E+02	5.12E+03	4.30E+03	1.63E+02	0.00E+00	9.85E+03
Rb-86	1.38E-01	1.00E+00	1.72E+00	1.79E+00	8.25E-01	5.48E+00
Sr-89	3.53E+00	3.46E+01	6.01E+01	6.43E+01	3.88E+01	2.01E+02
Sr-90	3.48E-01	3.42E+00	5.98E+00	6.51E+00	4.63E+00	2.09E+01
Sr-91	3.95E+00	3.06E+01	2.63E+01	5.00E+00	0.00E+00	6.58E+01
Sr-92	3.18E+00	1.45E+01	2.88E+00	1.25E-01	0.00E+00	2.06E+01
Y-90	6.34E-03	1.70E-01	9.06E-01	2.51E+00	4.25E+00	7.84E+00
Y-91	4.59E-02	4.70E-01	8.96E-01	1.03E+00	6.38E-01	3.08E+00
Y-92	4.89E-01	1.01E+01	8.31E+00	3.75E-01	0.00E+00	1.93E+01
Y-93	4.94E-02	3.87E-01	3.45E-01	7.25E-02	0.00E+00	8.54E-01
Zr-95	6.39E-02	6.26E-01	1.09E+00	1.18E+00	7.25E-01	3.68E+00
Zr-97	6.16E-02	5.28E-01	6.10E-01	2.25E-01	0.00E+00	1.43E+00
Nb-95	6.43E-02	6.30E-01	1.11E+00	1.20E+00	8.25E-01	3.83E+00
Mo-99	8.30E-01	7.86E+00	1.23E+01	9.88E+00	1.00E+00	3.19E+01
Tc-99m	7.46E-01	7.24E+00	1.19E+01	1.01E+01	8.75E-01	3.09E+01
Ru-103	6.66E-01	6.52E+00	1.13E+01	1.21E+01	6.88E+00	3.75E+01
Ru-105	3.48E-01	2.09E+00	8.88E-01	3.75E-02	0.00E+00	3.36E+00
Ru-106	2.33E-01	2.28E+00	3.99E+00	4.34E+00	3.04E+00	1.39E+01
Rh-105	4.05E-01	3.88E+00	5.85E+00	3.74E+00	1.25E-01	1.40E+01
Sb-127	9.09E-01	8.69E+00	1.40E+01	1.23E+01	1.75E+00	3.76E+01
Sb-129	2.18E+00	1.30E+01	5.25E+00	1.25E-01	0.00E+00	2.05E+01
Te-127	9.29E-01	8.96E+00	1.49E+01	1.39E+01	3.13E+00	4.18E+01
Te-127m	1.22E-01	1.20E+00	2.09E+00	2.29E+00	1.54E+00	7.24E+00

Table 15.4-23a Activity Releases for ESBWR Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total
Te-129	2.41E+00	1.62E+01	1.15E+01	6.75E+00	3.50E+00	4.04E+01
Te-129m	4.09E-01	4.02E+00	6.98E+00	7.35E+00	4.13E+00	2.29E+01
Te-131m	1.22E+00	1.11E+01	1.53E+01	8.75E+00	2.50E-01	3.66E+01
Te-132	1.24E+01	1.19E+02	1.88E+02	1.59E+02	1.88E+01	4.96E+02
I-131	6.66E+01	5.13E+02	9.33E+02	1.44E+03	7.00E+02	3.65E+03
I-132	7.88E+01	3.44E+02	2.45E+02	1.89E+02	2.25E+01	8.79E+02
I-133	1.31E+02	9.10E+02	1.22E+03	7.63E+02	1.25E+01	3.04E+03
I-134	4.96E+01	5.10E+01	3.75E-01	0.00E+00	0.00E+00	1.01E+02
I-135	1.11E+02	6.07E+02	4.16E+02	5.38E+01	0.00E+00	1.19E+03
Xe-133	1.08E+03	5.19E+04	4.08E+05	2.51E+06	1.20E+06	4.18E+06
Xe-135	3.68E+02	1.40E+04	5.13E+04	3.80E+04	0.00E+00	1.04E+05
Cs-134	1.16E+01	8.50E+01	1.48E+02	1.63E+02	1.14E+02	5.21E+02
Cs-136	4.03E+00	2.92E+01	5.00E+01	5.05E+01	2.00E+01	1.54E+02
Cs-137	7.54E+00	5.52E+01	9.60E+01	1.05E+02	7.50E+01	3.39E+02
Ba-139	2.96E+00	7.50E+00	3.00E-01	0.00E+00	0.00E+00	1.08E+01
Ba-140	6.26E+00	6.10E+01	1.04E+02	1.06E+02	4.00E+01	3.18E+02
La-140	1.40E-01	4.41E+00	2.37E+01	5.83E+01	4.35E+01	1.30E+02
La-141	4.50E-02	2.56E-01	9.13E-02	2.50E-03	0.00E+00	3.95E-01
La-142	2.84E-02	8.09E-02	4.50E-03	0.00E+00	0.00E+00	1.14E-01
Ce-141	1.49E-01	1.46E+00	2.54E+00	2.69E+00	1.46E+00	8.30E+00
Ce-143	1.35E-01	1.23E+00	1.75E+00	1.05E+00	2.50E-02	4.19E+00
Ce-144	1.21E-01	1.19E+00	2.08E+00	2.26E+00	1.55E+00	7.20E+00
Pr-143	5.46E-02	5.40E-01	9.68E-01	1.06E+00	4.63E-01	3.09E+00
Nd-147	2.38E-02	2.31E-01	3.94E-01	3.95E-01	1.39E-01	1.18E+00
Np-239	1.69E+00	1.59E+01	2.44E+01	1.88E+01	1.38E+00	6.21E+01
Pu-238	2.98E-04	2.93E-03	5.11E-03	5.54E-03	4.00E-03	1.79E-02
Pu-239	3.59E-05	3.53E-04	6.19E-04	6.80E-04	4.75E-04	2.16E-03
Pu-240	4.65E-05	4.56E-04	7.98E-04	8.75E-04	6.13E-04	2.79E-03

Table 15.4-23a Activity Releases for ESBWR Loss-of-Coolant Accident

	Activity Release (Ci)					
Isotope	**0–2 hr**	**2–8 hr**	**8–24 hr**	**24–96 hr**	**96–720 hr**	**Total**
Pu-241	1.35E-02	1.33E-01	2.31E-01	2.53E-01	1.78E-01	8.08E-01
Am-241	6.08E-06	5.97E-05	1.06E-04	1.15E-04	9.25E-05	3.79E-04
Cm-242	1.43E-03	1.40E-02	2.44E-02	2.65E-02	1.76E-02	8.39E-02
Cm-244	6.91E-05	6.77E-04	1.19E-03	1.29E-03	9.13E-04	4.14E-03
Total	2.46E+03	7.82E+04	4.76E+05	2.58E+06	1.25E+06	4.39E+06

Table 15.4-23b Doses for ESBWR Loss-of-Coolant Accident

	Site TEDE (Rem)	
Time	**EAB**	**LPZ**
2–4 hr	1.41E+00	
0–8 hr		4.14E-01
8–24 hr		2.66E-01
24–96 hr		2.03E-01
96–720 hr		2.72E-02
Total	1.41E+00	9.10E-01
Limit	25	25

Note: The maximum EAB dose occurs between 2 and 4 hours, and it is calculated based on the χ/Q between 0 and 2 hours.

Table 15.4-24 Activity Releases for AP1000 Fuel Handling Accident

Isotope	Activity Release (Ci) 0–2 hr
Kr-85m	2.68E-03
Kr-85	1.10E+03
Xe-131m	5.36E+02
Xe-133m	1.29E+03
Xe-133	6.94E+04
Xe-135m	4.37E-01
Xe-135	1.32E+02
I-130	3.52E-02
I-131	2.90E+02
I-132	1.54E+02
I-133	1.91E+01
I-135	1.36E-02
Total	7.29E+04

Table 15.4-25 Doses for AP1000 Fuel Handling Accident

	AP1000 TEDE (Rem)			Site TEDE (Rem)	
Time	EAB	LPZ	χ/Q Ratio (Site/AP1000)	EAB	LPZ
0–2 hr	2.40E+00		3.77E-01	9.04E-01	
0–8 hr		6.00E-01	1.52E-01		9.11E-02
8–24 hr		0.00E+00	1.36E-01		0.00E+00
24–96 hr		0.00E+00	1.03E-01		0.00E+00
96–720 hr		0.00E+00	7.05E-02		0.00E+00
Total	2.40E+00	6.00E-01		9.04E-01	9.11E-02
Limit				6.3	6.3

Table 15.4-26 Activity Releases for ABWR Fuel Handling Accident

Isotope	Activity Release (Ci) 0–2 hr
I-131	1.35E+02
I-132	1.66E+02
I-133	1.39E+02
I-134	6.74E-06
I-135	2.25E+01
Kr-83m	7.04E+00
Kr-85m	9.34E+01
Kr-85	5.23E+02
Kr-87	1.35E-02
Kr-88	2.66E+01
Kr-89	8.90E-11
Xe-131m	9.14E+01
Xe-133m	1.20E+03
Xe-133	3.08E+04
Xe-135m	2.42E+02
Xe-135	6.98E+03
Xe-137	2.27E-10
Xe-138	4.70E-10
Total	4.04E+04

Table 15.4-27 Doses for ABWR Fuel Handling Accident

	ABWR EAB Dose (S_v)			χ/Q Ratio	Site TEDE (Rem)	
Time	W. Body	Thyroid	TEDE	(Site/ABWR)	EAB	LPZ
0–2 hr	1.20E-02	7.50E-01	3.45E-02	1.65E-01	6.23E-01	
0–8 hr	1.20E-02	7.50E-01	3.45E-02	1.50E-02		5.65E-02
8–24 hr						0.00E+00
24–96 hr						0.00E+00
96–720 hr						0.00E+00
Total	1.20E-02	7.50E-01	3.45E-02		6.23E-01	5.65E-02
Limit					6.3	6.3

Note: The ABWR TEDE is whole body dose plus 3% of thyroid dose. The site LPZ dose is obtained by multiplying ABWR EAB dose by ratio of site LPZ χ/Q to ABWR EAB χ/Q. The site doses include a multiplier of 1.10 for power adjustment.

Table 15.4-28 Activity Releases for ESBWR Fuel Handling Accident

	Activity Release (Ci)
Isotope	0–2 hr
I-131	3.00E+02
I-132	2.43E+02
I-133	1.92E+02
I-134	1.05E-05
I-135	3.17E+01
Kr-85m	2.77E+02
Kr-85	1.01E+03
Kr-87	4.39E-02
Kr-88	8.78E+01
Xe-133	8.10E+04
Xe-135	2.13E+04
Total	1.04E+05

Table 15.4-29 Doses for ESBWR Fuel Handling Accident

	Site TEDE (Rem)	
Time	**EAB**	**LPZ**
0–2 hr	1.24E+00	
0–8 hr		1.13E-01
8–24 hr		0.00E+00
24–96 hr		0.00E+00
96–720 hr		0.00E+00
Total	1.24E+00	1.13E-01
Limit	6.3	6.3

Table 15.4-30 Activity Releases for ESBWR Cleanup Water Line Break

	Activity Release (Ci)
Isotope	**0–2 hr**
I-131	3.48E+01
I-132	7.05E+01
I-133	9.28E+01
I-134	1.22E+02
I-135	9.59E+01
Total	4.16E+02

Table 15.4-31 Doses for ESBWR Cleanup Water Line Break

	Site TEDE (Rem)	
Time	**EAB**	**LPZ**
0–2 hr	1.75E-01	
0–8 hr		1.59E-02
8–24 hr		0.00E+00
24–96 hr		0.00E+00
96–720 hr		0.00E+00
Total	1.75E-01	1.59E-02
Limit	2.5	2.5

Chapter 17 Quality Assurance

The Early Site Permit Application Development Quality Assurance Manual establishes the quality assurance plan for the development of the ESP application. The plan has been structured around Virginia Power's operational Quality Assurance Plan for the existing units and uses many of the same procedures and programs.

17.1 ESP Quality Assurance

The Early Site Permit Application Development Quality Assurance Manual is included in Section 17.1.

Dominion

Quality Assurance Manual

Title: Early Site Permit Application Development Quality Assurance Manual

Process/Program Owner: **Project Manager – Early Site Permit Project**

	Revision Number	**Effective Date**
	2	**August 29, 2003**

Revision Summary

Revision 2:

- Changed title of Senior Vice President and Chief Nuclear Officer to Senior Vice President – nuclear Operations and chief Nuclear Officer to comply with corporate structure.
- Revised Section 3, General Description, Objective to reference the operational Quality Assurance Topical Report for specific guidance on implementation of 10 CRF50 Appendix B.
- Deleted Appendix B Table 2 as it is not needed with the above change to Section 3.

Signatures on File in Records Management

Prepared by: __________________/_________
Spencer W. Semmes 8/19/03

Reviewed By:	Reviewed By:	Approved By:
Marvin L. Smith 8/19/03 ________________/_________ Project Manager - ESP	Kerry L. Rhoads for R. M. Berryman 08/25/2003 ________________/_________ Director Nuclear Oversight	Eugene S. Grecheck 8/25/03 ________________/_________ Vice President Nuclear Support Services

Table Of Contents

1. Introduction

This manual delineates the Quality Assurance Plan for the development of an Early Site Permit Application for the addition of new nuclear generation. It has been developed with guidance from ASME-NQA-1-2000.

The Quality Assurance Program (QA Program) outlines the organization, programs and procedural requirements that will assure that the application is developed in a quality manner and, where appropriate, in accordance with 10CFR50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants."

In order to simplify the QA process for the Early Site Permit Application development, elements of the operating QA program shall be used to assure quality. The operating QA program, VEP-1-5A, Operational Quality Assurance Program Topical Report has detailed implementing procedures in place, but has been developed to specifically exclude construction activities. The Early Site Permit Application Development Quality Assurance Manual provides details for the QA process for the development of an Early Site Permit Application and specifies the use of the processes in place that meet the operating QA program.

Where applicable, items that may or will affect the operating unit or units shall be addressed under the operating QA program, VEP-1-5A, Operational Quality Assurance Program Topical Report. In selected cases as stated in this document, the existing operating QA program. VEP-1-5A will govern compliance with this program. Also, many procedures and instructions that comply with the Operational Quality Assurance Program shall also be used to comply with this program.

Control, revision and approval of this manual will be performed in accordance with Section 20, Issuance and Revision of the Early Site Permit Application Development QA Manual.

2. Organization

General Description - Early Site Permit Development Organization

There are five groups within the Early Site Permit Development Organization which affect the quality of the Early Site Permit Application. These groups are Early Site Permit Project, Nuclear Operations, Nuclear Engineering, Nuclear

Support Services, and Nuclear Oversight. The Nuclear Organization is shown in Appendix A. A more specific description of the responsibilities of each group is listed below.

A. Early Site Permit Project

The Early Site Permit Project is responsible for development of the Early Site Permit Application, coordinating the technical input required, managing subcontractors and assuring that all licensing requirements are met. The Early Site Permit Project is the design authority for development of the Early Site Permit.

B. Nuclear Support Services

Nuclear Support Services is responsible for support of the Early Site Permit Organization by providing licensing and operations support, personnel training, nuclear security and emergency preparedness support. The Early Site Permit Project is part of the Nuclear Support Services organization.

Supply Chain Management (Generation) is responsible for providing material management, procurement, procurement engineering and other supply chain functions. The Supply Chain Management (Generation) Group is matrixed to Nuclear Support Services.

C. Nuclear Operations

Nuclear Operations is responsible for operation and maintenance of the Nuclear Stations and Independent Spent Fuel Storage Installations (ISFSIs). In addition, Nuclear Operations is responsible for quality inspection activities for on site work, including that to support the Early Site Permit application development, as necessary.

D. Nuclear Engineering

Nuclear Engineering is responsible for support of the Early Site Permit Organization by providing engineering services and records management. The engineering departments provide design engineering support.

Information Technology is responsible for providing information technology services to the nuclear organization. The Information Technology Group is matrixed to Nuclear Engineering.

E. Nuclear Oversight

Nuclear Oversight is responsible for independently planning and performing activities to verify the development and effective implementation of nuclear management's quality assurance programs for engineering, procurement, and construction activities associated with the Early Site Permit development.

Nuclear Management

A. Senior Vice President – Nuclear Operations and Chief Nuclear Officer

The Senior Vice President - Nuclear Operations and Chief Nuclear Officer has corporate responsibility for and directs the planning and development of the Early Site Permit Organization staff, and organization resources.

B. Vice President Nuclear Support Services

The Vice President Nuclear Support Services is responsible to the Senior Vice President - Nuclear Operations and Chief Nuclear Officer and has the responsibility for development of the Early Site Permit Application.

The Vice President Nuclear Support Services has overall responsibility for implementing the quality assurance program for the Early Site Permit Organization.

1. Project Manager – Early Site Permit Project

The Project Manager – Early Site Permit Project is responsible to the Vice President Nuclear Support Services for developing the Early Site Permit Application and assuring that the Application meets all of the requirements of the quality assurance program.

The Project Manager – Early Site Permit Project has overall authority for all activities in support of the development of the application. He is responsible for vendor interface for all vendor-related activities, such as collecting and analyzing data and conducting testing for site suitability. He is also responsible for coordinating actions of Dominion personnel and departments.

2. Director Nuclear Licensing & Operations Support

Director Nuclear Licensing & Operations Support is responsible to the Vice President Nuclear Support Services for providing regulatory compliance support, and providing licensing support through NRC communications.

3. Director Nuclear Protection Services & Emergency Preparedness

Director Nuclear Protection Services & Emergency Preparedness is responsible to the Vice President Nuclear Support Services for providing nuclear station security, plant and ISFSI access programs, station safety and loss prevention, and fitness for duty programs. The Director Nuclear Protection Services & Emergency Preparedness is also responsible for the overall management of Nuclear Emergency Preparedness activities and is responsible for development of the emergency planning sections of the Application. Additional responsibilities include controlling site access, implementation of the Fitness for Duty program and ensuring that construction or ESP activities do not breach security measures of the operating plants.

4. Director Nuclear Training

Director Nuclear Training is responsible to the Vice President Nuclear Support Services for the training of personnel who operate or support the Nuclear Stations. Training responsibilities include: determining the need for training based on information provided by the Early Site Permit Organization, developing performance-based training programs, implementing training programs to support employee and organization needs, and evaluating training programs. Additional responsibilities include assuring that personnel are properly trained to respond to potential hazards while on site.

5. Director Supply Chain Management (Generation)

The Director Supply Chain Management (Generation) is responsible to the Vice President Nuclear Support Services for the material management, purchasing, procurement engineering, and vendor surveillance functions. This responsibility is exercised in a matrixed-reporting role.

C. Director Nuclear Oversight

The Director Nuclear Oversight is responsible to the Senior Vice President - Nuclear Operations and Chief Nuclear Officer for assuring the compliance with the Quality Assurance Program for Early Site Permit Application development. The Director Nuclear Oversight may make recommendations to the Early Site Permit Development Organization's management. If the Director of Nuclear Oversight disagrees with any actions taken by the Early Site Permit Development Organization and is unable to obtain resolution, the Director Nuclear Oversight shall bring the matter to the attention of the Senior Vice President - Nuclear Operations and Chief Nuclear Officer who will determine the final disposition.

1. Supervisor Nuclear Quality (Vendor Programs)

The Supervisor Nuclear Quality (Vendor Programs) is responsible to the Director Nuclear Oversight for assuring compliance with the established vendor Quality Assurance Programs and for evaluating the quality programs of vendors and contractors performing ESP activities important to safety. This is accomplished by scheduling and conducting triennial external audits, annual vendor Quality Assurance Program evaluations, reviewing audits conducted by external organizations (e.g., other utilities and NUPIC), and maintenance of the Safety-Related Vendors List and the Commercial Grade Vendors List.

2. Nuclear Specialist (Audit Coordinator)

The Nuclear Specialist (Audit Coordinator) is responsible to the Director Nuclear Oversight for assuring compliance with the Operational Quality Assurance Program, administration of the internal audit program, and interfacing with corporate Nuclear Oversight personnel.

D. Vice President Nuclear Engineering

The Vice President Nuclear Engineering is responsible to the Senior Vice President - Nuclear Operations and Chief Nuclear Officer and has corporate responsibility for supporting development of the Early Site Permit Application through engineering, projects, and nuclear analysis and fuel activities.

1. Director Information Technology Business Account (Generation)

The Director Information Technology Business Account (Generation) is responsible to the Vice President Nuclear Engineering for information technology direction and support of the Nuclear Business Unit. This responsibility is exercised in a matrixed-reporting role. Responsibilities include network infrastructure maintenance and upgrade, network and application security, network operations, automation strategy, application development and support, and automation training. Additional responsibilities include the evaluation of software quality for that software utilized within Dominion.

2. Director Nuclear Engineering

The Director of Nuclear Engineering is responsible to the Vice President Nuclear Engineering for implementing the operational quality assurance program in the following areas:

- Design Engineering
- Configuration Management
- Site Engineering
- Records Management

Responsibilities of these groups include implementing engineering standards for nuclear design control, engineering evaluation of generic industry issues, management of engineering resources for specific tasks, and engineering programs.

a. Manager Design Engineering

The Manager Design Engineering is responsible to the Director Nuclear Engineering for orchestrating the resources of the corporate discipline engineering groups, and Site Design Engineering to support the competing needs of projects, general site support activities and program support. The Manager Design Engineering shall also ensure that appropriate discipline engineering resources are dedicated to the maintenance of the design basis infrastructure and support of assigned programs.

b. Manager Nuclear Site Engineering

The Manager Nuclear Site Engineering is responsible to the Director Nuclear Engineering for managing engineering resources in Systems Engineering, Component Engineering, and Test and Inspection Engineering. The Manager Nuclear Site Engineering also provides a day-to-day interface with Station management.

c. Manager Nuclear Engineering

The Manager Nuclear Engineering is responsible to the Director Nuclear Engineering for managing activities related to the control and availability of design and licensing basis information, configuration management, and the control of nuclear records through effective implementation of the records management program.

E. Senior Vice President Nuclear Operations

The Senior Vice President Nuclear Operations is the corporate individual responsible to the Senior Vice President – Nuclear Operations and Chief Nuclear Officer for the operation of the Nuclear Stations and ISFSIs. The Senior Vice President Nuclear Operations has overall responsibility for implementing the quality assurance program for the operational phase of the Nuclear Stations and ISFSIs.

F. Site Vice President

Responsible to the Senior Vice President Nuclear Operations for the overall safe and efficient operation of the station and ISFSI, and for the implementation of quality assurance requirements in the areas specified by the Operational Quality Assurance Program.

For the purposes of this program, the description of the duties of the Site Vice President and staff will be limited to those that impact the Early Site Permit Application Development. All other topics are addressed in the Operational Quality Assurance Program.

The Site Vice President has supervisory control over all Company personnel within the station organization and administrative control over all other Company and non-Company individuals within the nuclear site's boundary. The Site Vice President is the local representative of Company management and is empowered to implement all Company policy with regard to operations of the facility, support of Company public relations policy, and employee relations policies. The Site Vice President is also responsible for coordinating station functions with offsite (Company and non-Company) agencies and services, and ensuring station personnel are adequately trained in accordance with the Emergency Plan. The Site Vice President fulfills the position of Plant Manager identified in the ISFSI Technical Specifications.

Director Nuclear Station S&L (Safety and Licensing)

The Director Nuclear Station S&L is responsible to the Site Vice President for directing and coordinating nuclear safety issues at the station and ISFSI. The Director Nuclear Station S&L is independent of cost and scheduling concerns associated with operations, maintenance, construction, and modification activities. The Director Nuclear Station S&L is responsible for being cognizant of licensing and regulatory issues, administering the Commitment Tracking System (CTS), coordinating the station quality inspection program, and coordinating activities related to non-radiological environmental protection.

3. Quality Assurance Program

General Description

Objective

The objective of the Dominion Quality Assurance Program for Early Site Permit Applications is to comply with the criteria as expressed in 10 CFR 50, Appendix B, as amended, and with the quality assurance program requirements for nuclear power plants as described in the Operational Quality Assurance Program Topical Report, VEP-1-5A. This program, its policies and procedures are described herein: the Early Site Permit Quality Assurance Program; the Nuclear Business Unit Standard (NBUS); and the corporate and station procedures. This program applies to those quality-related activities that involve the functions of safety-related structures, systems, and components associated with the construction of nuclear power stations and those non-safety-related components described in the Site Safety Analysis Report. Examples of safety-related activities for the ESP program include, but are not limited to, site geotechnical investigations, seismic analysis, and meteorological analysis.

Other portions of the Early Site Permit Application shall be developed under a graded approach to quality, with appropriate controls applied to ensure accuracy of information and conformance/compliance with applicable codes, standards, regulatory requirements, and industry practices.

Elements of the Operational Quality Assurance Program, VEP-1-5A, Operational Quality Assurance Program Topical Report, shall be used to assure compliance with this document. The existing programs and procedures to support the Operational Quality Assurance Program shall also be used. These programs include a Design Control process (which also controls engineering vendor and Architect-Engineer interface) and Record Retention processes.

Designated activities may be performed under a contractor's Quality Assurance Program approved by the Dominion Quality Assurance Program. The contractor's Quality Assurance Program when used for activities will comply with the criteria expressed in 10 CFR 50, Appendix B, as amended, and with the Regulatory Guides and ANSI Standards as listed in Table 2. Periodic audits and assessments of those programs are performed to assure compliance with Dominion procedures. In addition, routine interfaces with project personnel assure that quality expectations are met.

The goal of this program is to assure the accurate, efficient and detailed development of an Early Site Permit Application in accordance with sound engineering principles.

Site development in preparation for construction is not within the scope of the Early Site Permit Project

This Quality Assurance Plan applies to those ESP activities that can affect either directly or indirectly the safety-related site characteristics or analysis of those characteristics. In addition, this plan applies to engineering activities that are used to characterize the site or analyze that characterization.

In general, the requirements specified here are detailed in implementing procedures that are either Dominion implementing procedures, or vendor implementing procedures governed by a vendor quality program. Vendor quality programs shall be verified to be in compliance with this Dominion plan in accordance with administrative procedures.

Process

The program provides written policies, standards, procedures, and instructions covering engineering, design, procurement, periodic surveillance, and supporting tests, for the development of the Application. Nuclear Business Unit (NBU) policies establish commitments to the Quality Assurance Program. Detailed procedures and instructions are issued in accordance with and to meet the requirements of this document. Audit and inspection programs have been implemented to assure that these procedures are being correctly applied.

Nuclear Oversight personnel, both station and corporate, report through a line of management completely separate from operational, Early Site Permit application development, and production management and influences, and fulfill the following three-part role:

1. Audit to ensure that the overall development of the Application is carried out in accordance with applicable codes and standards, NRC guides and regulations, company policies and commitments.
2. Serve as a management tool for station and corporate management personnel, illuminating problem areas, detecting trends, and providing recommendations regarding solution of problem areas when applicable.
3. Provide all levels of management with an independent source of information regarding the quality aspect of Application development and comment resolution.

Issue Resolution

Differences of opinion between Nuclear Oversight personnel and other departments are resolved by the cognizant Manager or Director and the Director Nuclear Oversight or are forwarded through normal administrative chains of both individuals for resolution at the executive level. Final decision-making authority rests with the Senior Vice President and Chief Nuclear Officer.

Audits

Nuclear Oversight conducts audits in accordance with the Quality Assurance Program and performs other duties as directed by the Director Nuclear Oversight. Nuclear Oversight representatives have access to all areas at any time deemed necessary for audits and activities related to quality. They have access to station and corporate records required for in-depth auditing of Application development, including confidential personnel records (but only to the extent necessary to verify personnel qualifications or other information related to quality).

The station staff, under the guidance of the Director Nuclear Station S&L (Safety and Licensing) conducts inspections of work at the stations.

Other personnel assigned to conduct assessments and inspections in accordance with the Quality Assurance Program have access to all areas of the station necessary to accomplish those activities.

Quality Assurance Program

The Dominion Quality Assurance Program for the Early Site Permit Application Development is displayed in a point-by-point comparison to Appendix B, 10 CFR 50 in Table 1.

Identification of Safety Related Design Basis Activities

Safety Related Design Basis Activities are defined as those activities, including sampling, testing, data collection and supporting engineering calculations and reports that will be used to determine the bounding physical parameters of the site. The development of the Application will involve site testing, data collection and calculations that may create or bound safety related design basis data. Site testing and data collection of information pertaining to the physical characteristics of the site will be considered safety related. In addition, calculations and other engineering data that bounds or characterizes the site will be classified as safety related.

Periodic Review of the Quality Assurance Program

Audits of activities required by the Quality Assurance Program for the Early Site Permit Application development will be conducted at least once per 24 months during the application development and NRC review processes. These audits are performed under the cognizance of the Director of Nuclear Oversight.

Qualification of Nuclear Oversight Personnel

The Director Nuclear Oversight shall have a four-year accredited engineering or science degree or equivalent with a minimum of ten years experience related to electric power generating facilities. At least five years of overall experience shall have been in a supervisory capacity, two years of which should have involved quality assurance related matters.

The Supervisor Nuclear Quality (Vendor Programs) shall have a four-year accredited engineering or science degree, or equivalent with a minimum of two years overall experience or equivalent training in power plant operations is a prerequisite with at least one year of this experience involved in nuclear power station quality assurance program implementation.

The Nuclear Specialist (Audit Coordinator) shall have a four-year accredited engineering or science degree, or equivalent with a minimum of two years overall experience or equivalent training in power plant operations is a prerequisite with at least one year of this experience involved in nuclear power station quality assurance program implementation.

Personnel in the key positions listed will meet or exceed the above requirements or, as an alternative, the applicable requirements of paragraph 4.4.5 of ANSI/ANS 3.1 (Draft 12/79) as clarified in VEP-1-5A, Operational Quality Assurance Program Topical Report.

Qualification of Other Support Personnel

The Manager Vendor Quality shall have a four-year accredited engineering or science degree, or equivalent with a minimum of two years overall experience or equivalent training in power plant operations. At least one year of this experience shall be involved in nuclear power station quality assurance program implementation.

Replacement personnel in the key positions listed will meet or exceed the applicable requirements of ANSI/ANS 3.1 (Draft 12/79) as clarified in VEP-1-5A, Operational Quality Assurance Program Topical Report.

Certification of Nuclear Oversight Personnel

The certification of Nuclear Oversight personnel is accomplished in accordance with the Quality Assurance Certification Program. This program provides for the certification and recertification of auditors and lead auditors. The program outlines the qualification and certification requirements for personnel and requires the individual to be certified prior to performing specified audit functions. Nuclear Oversight management has the responsibility to certify audit personnel.

Certification of Other Support Personnel

The certification of maintenance and modification inspection personnel [i.e., Quality Maintenance Team (QMT) and station Quality Control inspectors)], Material Verification personnel and Vendor Surveillance personnel is accomplished in accordance with the approved certification programs. These programs outline the qualification and certification requirements of personnel and require the individual to be certified prior to performing specified functions.

Indoctrination and Training

All personnel performing or managing activities affecting quality shall receive indoctrination and training in their job responsibilities and authority, general criteria including applicable codes and standards, regulatory commitments, company procedures and quality assurance program requirements.

A training program shall be established for those individuals responsible for work affecting safety related design basis activities.

Records of required training shall be maintained in accordance with section 18 of this program.

4. Design Control

The Nuclear Design Control Program (NDCP), delineates procedures to assure that design basis, regulatory requirements, codes and standards are correctly translated into specifications, drawings, procedures, or instructions for those items classified as safety related and that design changes, including field changes, are subject to design control measures commensurate with those applied to the original design and the applicable specified design requirements. Nuclear Standards describe the design control program.

The responsibility for the development, identification of requirements, monitoring, and implementation of an effective design control program is delegated to the Vice President Nuclear Engineering with input as appropriate from Vice President Nuclear Support Services. If changes to the operating units are required to support the development of the Early Site Permit Application, those activities shall be governed by VEP-1-5A, Operational Quality Assurance Program Topical Report.

The NDCP provides for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program. When a testing program is solely used to test the adequacy of a design, the test will be conducted under adverse design conditions. The provisions of this section assure that individuals other than those who performed the original design perform the verifying or checking process. These individuals are identified and their authority and responsibility is described. The NDCP also identifies the design documents that are required to be reviewed and the personnel responsible for their review and revisions, to assure that design characteristics can be controlled, inspected and tested, and that inspection and test criteria are identified. Design documents, design change documents and revisions thereto are distributed to responsible supervisors to determine whether revisions to controlled design and operating documents are necessary. Design documents and reviews, records and changes thereto are collected, stored and maintained in a systematic and controlled manner.

The NDCP establishes measures for the selection and review for suitability of application of materials, parts, equipment and processes that are essential to safety-related or safety significant functions. These measures include the use of valid and applicable industry standards and specifications, materials and prototype hardware testing programs, and design reviews. In the event of a design modification to a system which is safety related, engineering studies are initiated to evaluate parts, equipment, processes, and material suitability for repair of such equipment or components; previously approved items are used without further review. Previously approved materials, parts or components used for a different application are reviewed for suitability prior to approval for their new application.

Quality measures are assured through all levels of the design control program by the design control organization, station and corporate support organizations. Any errors or deficiencies noted in the design process are documented on the design change forms and subsequently corrected. Any non-conforming conditions identified are documented and corrected in accordance with the Corrective Action Process (section 17).

Procedures for design controls, analysis, and reviews have as their basis the applicable portions of documents referenced in the Nuclear Design Control Manual, and include ANSI N45.2.11-1974 as modified in Table 17.2.0 of VEP-1-5A, Operational Quality Assurance Program Topical Report.

An Engineering Standard is used to establish the interface between the company and contractors for design activities. The standard requires that the licensee’s program requirements be followed in the preparation, review and approval of design documents such as design changes, specifications and drawings.

Suitable design controls are applied to such disciplines as reactor physics; seismic stress, thermal, hydraulic, radiation and accident analysis, compatibility of materials; and accessibility for inservice inspection, maintenance and repair. Designs are reviewed to assure that (1) design characteristics can be controlled, inspected, and tested, and (2) inspection and test criteria are identified.

Some activities described in this section are included in the operational QA program and may not be needed for ESP application development. Examples of safety-related activities for the ESP program include, but are not limited to, site geotechnical investigations, seismic analysis, and meteorological analysis.

5. Procurement Document Control

Administrative procedures describe the program for completing procurement documents including review, approval, document control, and change control. In addition, references to procedures that govern the actions of Nuclear Oversight and Vendor Surveillance are made which include provisions for access to the suppliers' facilities and records, for source inspection or audit, and qualification of vendors prior to the initiation of quality related actions when the need for such inspection and/or audit has been determined. This program also provides for records to be prepared, maintained, made available for review, or delivered to the Company prior to use or installation of the hardware, such as drawings, specifications, procedures, procurement documents, inspection and test records, personnel and procedure qualifications, material, chemical and physical tests results, and the identification of quality assurance requirements applicable to the items or services purchased, including sub-tier procurement requirements when required.

Administrative procedures are established to ensure that procurement documents reference all actions required by a supplier in accordance with the applicable codes, specifications, and drawings. Any non-conforming conditions identified shall be documented and corrected in accordance with the Corrective Action Process (section 17).

Procurement documents incorporate the design basis technical and quality requirements including the applicable regulatory requirements, component and material identification requirements, drawings, specifications, codes and industrial standards, test and inspection requirements, and special instructions for special processes such as welding, heat treating, non-destructive testing and cleaning as applicable. Design basis information is developed in accordance with the Design Control process (Section 4).

Procurement documents for spare or replacement parts of safety-related structures, systems and components are subject to technical and quality controls at least equivalent to those used on the original equipment.

Procurement documents are prepared, reviewed, and approved as delineated in administrative controls. Copies of procurement documents, or equivalent documents such as Receiving Reports or Requisitioner's Purchase Orders, are retained and are available for review. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

Some activities described in this section are included in the operational QA program and may not be needed for ESP application development. For development of the ESP Application, activities subject to this criterion are limited to the procurement of vendor services.

6. Instructions, Procedures and Drawings

Detailed written procedures are established, approved, implemented, and maintained to control development of the Application.

Other activities affecting quality of safety related items within the scope of 10 CFR 50, Appendix B are prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances. These activities are accomplished in accordance with these instructions, procedures, or drawings. Applicable instructions, procedures, or drawings include for reference appropriate qualitative and/or quantitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

Administrative procedures describe the requirements for developing, reviewing, approving, and controlling procedures, instructions and drawings used for testing as well as design development, administrative, and other activities performed in support of development of the Application. These requirements include references, prerequisites, precautions, limitations, manufacturer's specifications, check-off lists, and acceptance criteria (as appropriate). When applicable the acceptance limits and requirements contained in the design and procurement documents constitute a portion of the acceptance criteria referenced and contained in written testing procedures.

Changes to procedures or instructions require the procedure or instruction to be revised before a change can be implemented. The revision process will have the same level of review as the original procedure or instruction. Drawing changes are controlled under the Design Control process (Section 4).

New procedures and instructions and procedure or instruction revisions are also reviewed using an Activity Screening to determine if any impact exists on the operating unit and if so, whether a safety evaluation is required. If the procedure, instruction or drawing has an impact on the operating unit, review and approval of the procedure, instruction or drawing shall be accomplished in accordance with VEP-1-5A, Operational Quality Assurance Program Topical Report. Revisions that do not require a safety evaluation and have no impact on the operating unit are reviewed by cognizant management prior to implementation. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures, drawings and instructions implementing this section are based.

7. Document Control

Measures are established and documented describing the control of documents, such as procedures, instructions, and drawings, to provide for their review, approval, and issue, and changes thereto, prior to release and to assure they are adequate and the quality requirements are stated. Normally changes to documents are reviewed and approved by the same organizations that performed the original review and approval; however, this responsibility may be delegated to other qualified responsible organizations. Approved changes are incorporated into procedures and drawings and other appropriate documents associated with the change. Procedures, drawings and instructions and changes thereto are processed, distributed and controlled and obsolete copies are disposed of. The company maintains a record of all holders of procedures and drawings and an index of all procedures and drawings, listing the current revision date. Instructions require that a copy of the appropriate procedure be available at the activity location prior to the commencement of that activity. These measures are addressed in the Administrative Procedures for each station.

Administrative procedures list certain documents that require strict administrative control for distribution, revision, and routing. These documents are categorized as "Controlled Documents." Examples of controlled documents are Station Procedures, and Station Drawings. Also set forth are the distribution and controlling procedures for design and procurement documents. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based. Record Retention will be in accordance with Table 17.2-2 of VEP-1-5A.

8. Control of Purchased Material, Equipment and Services

An evaluation of suppliers is performed prior to contract award, except in emergency situations where an item or service is needed to preclude development or deterioration of an unsafe condition at the plant, by one or more of the following: (1) A review of the supplier's capability to comply with the elements of 10 CFR 50, Appendix B that are applicable to the type of material, equipment, or service being procured, (2) A review of previous records and performances of suppliers who have provided similar articles of the type being procured, (3) A survey of the supplier's facilities and quality assurance program to determine his capability to supply a product or service which meets the design, manufacturing, and quality requirements, or (4) A review of qualification information supplied by another utility or outside organization.

Surveillance of suppliers during fabrication, inspection, testing, and shipment of materials, equipment, and components is planned and performed in accordance with written procedures to assure conformance to the purchase order requirements as applicable. These procedures provide for:

a. Instructions that specify the characteristics or processes to be witnessed, inspected or verified, and accepted; the method of surveillance and the extent of documentation required; and those responsible for implementing these instructions. Surveillance shall be performed on those items where verification of procurement requirements cannot be determined on receipt.

b. Audits and/or inspections which assure that the supplier complies with all quality requirements.

Administrative procedures describe the requirements for controlling purchased material, equipment, and services including commercial grade items for use on safety-related applications. The requirements applied to spare and replacement parts are at least equivalent to those applied to the original parts.

Inspections and surveillance of suppliers of nuclear safety-related items is performed under the direction of the Vice President Nuclear Engineering and the Vice President Nuclear Support Services. The results of these actions are documented and filed. The periodic inspections assure that applicable material and equipment received at the station meet the requirements of the specifications, purchase orders, code, drawings, or other purchasing documents. This assurance includes the review of documentation received, physical inspection, cleanliness, packaging, marking or functional testing, as required.

Purchased items are normally under the control of the Supply Chain Management (Generation) organization. This organization is authorized to contact system organizations and NSSS, A/E contractors and subcontractors through the auspices of system representatives for assistance as required. Verification of these activities is accomplished under the direction of the Director Nuclear Oversight.

Any non-conforming conditions identified are documented and corrected in accordance with the Corrective Action Process (section 17).

Periodic evaluations of procurement history of the suppliers are performed by Nuclear Oversight to verify continued supplier capability.

Documentation concerning the quality of material, components, and equipment received is reviewed by a representative of the Vice President Nuclear Engineering or the Vice President Nuclear Support Services for conformance with the Purchase Requisition and Purchase Order. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

9. Identification and Control of Materials, Parts and Components

During the development of an Early Site Permit Application, no safety-related materials, parts or components will be procured or used. For this reason, this criterion is not applicable to the development of an Early Site Permit Application.

10. Control of Special Processes

The safety-related scope of the development of the ESP application will not involve the use of special processes. For this reason, this criterion is not applicable to the development of an Early Site Permit Application.

11. Inspection

Inspection procedures for those activities affecting quality will be established as appropriate, prior to work being performed. Written procedures will be developed as needed to include inspection hold points.

Examinations, measurements, or tests of materials or components associated with safety-related equipment and systems are performed for each work operation, where necessary, to assure quality. If inspection is impossible or inappropriate, indirect control by monitoring methods, equipment, and personnel is provided. Both methods are provided when control is inadequate without both.

Examinations, measurements, or tests that require witnessing are identified as “inspection hold” points in procedures. The inspection performed at a hold point is specific in nature; quality characteristics and acceptance/rejection criteria are included or qualitative criteria such as operability checks, compliance with procedural steps, or cleanliness instructions are specified. The inspection is documented by signature or initials on the written procedure form.

The inspection program requires that inspectors be assigned as appropriate for the activity being inspected. An inspector may be a member of the organization performing the activity. However, they must be qualified and shall not be the person performing the activity or the supervisor directly responsible for the activity. Maintenance and modification inspection personnel are under the administrative direction of the Quality Inspection Coordinator when performing Quality Control inspections. Personnel so assigned shall become familiar with the procedure being used and other pertinent documents such as technical manuals and drawings prior to performing the inspection.

Maintenance and modification inspection personnel, Material Verification personnel and Vendor Surveillance personnel meet the qualification requirements of ANSI N45.2.6-1978, under NRC Regulatory Guide 1.58 as clarified in VEP-1-5A, Operational Quality Assurance Program Topical Report

Table 17.2-0. The inspectors' qualifications are periodically reviewed for recertification.

Generally, all physical inspections are under the control of the on-site organization. However, the Site Vice President is authorized to request assistance as required from corporate support organizations.

Additionally, inspection activities pertaining to Design Control (Section 4); Procurement Document Control (Section 5); and Corrective Action (Section 17) shall be controlled in accordance with provisions established for this function in the referenced sections contained herein. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

Some activities described in this section are included in the operational QA program and may not be needed for ESP application development. The performance of site geotechnical investigations is an example of a safety-related activity for the ESP program that may involve inspections to assure compliance with procedures.

12. Test Control

Testing done in support of the Early Site Permit application development will be controlled by written test procedures. These test procedures will include or reference:

1. The requirements and acceptance limits contained in applicable design and procurement documents.

2. Test prerequisites such as the availability of adequate and appropriate equipment and calibrated instrumentation; trained, qualified, and licensed or certified personnel; the completeness of the item to be tested; suitable and controlled environmental conditions; provisions for data collection and storage.

3. Instructions for performing the test.

4. Inspection points as appropriate.

5. Acceptance and rejection criteria.

6. Methods of documenting or recording test data and results.

Any instrumentation used shall be in a calibration program. This program provides, by the use of equipment history data, status, records, and performance schedules, for the date that calibration is due and indicates the status of calibration. The identity of person(s) performing calibration is provided on the calibration documents. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

13. Control of Measuring and Test Equipment

A program has been established and documented in administrative procedures that describes the calibration technique and frequency, maintenance, and control of all “Measuring and Test Equipment” (portable instruments, tools, gauges, fixtures, reference and transfer standards, and non-destructive test equipment) which are used in the measurement, inspection, maintenance, and monitoring of safety-related components, systems, and structures. Measuring and test equipment does not include: measuring equipment used for preliminary checks or utility troubleshooting where accuracy is not required. There is also no intention to imply a need for special calibration and control measures of rulers, tape measures, levels, and other basic tools if normal commercial practices provide adequate accuracy. Controls for measuring and test equipment include the transportation, storage, and protection of the equipment; the handling of associated documents giving the status of all items under the calibration system such as maintenance history, calibration test data, and individual log sheets assigned to each device; and the permanent marking of each device by a unique number.

The maintenance, calibration technique, and frequency of calibration of measuring and test equipment utilized in activities affecting quality are normally performed as specified in the manufacturer’s instruction manual or in approved written procedures. In some cases the calibration interval may be assigned or changed based on accumulated experience by trained technicians. The recall system may include provisions for the temporary extension of the calibration due date under certain conditions specified in approved procedures.

If standards are not available or there is some special reason that procedures cannot be followed, the modified procedures and/or interval are documented, including justification. In other cases, rather than require calibration at specified intervals, procedures may specify the device be calibrated prior to use, as in the case of torque wrenches or micrometers. Where permitted by commercially available state of the art equipment, reference standards are no more than 1/4 the error allowed in the measuring and test equipment calibrated by that standard.

Measuring and test equipment used on safety-related systems or equipment are calibrated utilizing reference standards whose calibration has a known valid relationship to nationally recognized standards, such as the National Institute of Standards and Technology (NIST), or accepted values of natural physical constants. If no national standard exists, the basis for calibration is documented. Whether the device is calibrated at the power station or at an NIST traceable outside laboratory, one or more stickers are affixed on a conspicuous surface identifying, but not limited to, date of calibration and next calibration due date.

When measuring and test equipment utilized in activities affecting quality are found to be out of calibration an evaluation will be performed and documented concerning the validity of previous tests and the acceptability of devices previously tested. All previous tests and measurements performed during the current or proceeding calibration cycle shall be redone if the evaluation so indicates.

Implementation of the measuring and test equipment programs is assured through Nuclear Oversight audits and through inspections by the appropriate line organizations during performance of work. The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

14. Handling, Storage and Shipping

Measures have been established in administrative procedures to provide adequate methods by qualified personnel for the classification, packaging, cleaning, preservation, shipping, storage, and handling of material and equipment received at the station.

These measures, prepared in accordance with design and specification requirements, define responsibility, levels of cleanliness, tagging, and storage levels for categorized items.

The procedures also control cleaning, handling, storage, packaging, shipping, and preservation of materials, components, and systems to preclude damage, loss, or deterioration by environmental conditions such as temperature or humidity. Implementation of these measures is verified through inspections by Materials Verification and Vendor Surveillance inspectors.

The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

Some activities described in this section are included in the operational QA program and may not be needed for ESP application development. The handling, storage, and potential shipping of soil samples taken during site geotechnical investigations is an example of a safety-related activity for the ESP program that is subject to this criterion

15. Inspection, Test and Operating Status

Measures for the identification and documentation of the inspection and test status for items to prevent inadvertent bypassing of specified inspections and tests are established in administrative procedures and in station operating procedures. These measures define the three general categories of inspection and test status for items: Accept, Reject, or Hold. They provide for status identification through the use of stickers, tags, record cards, test records, check-off lists, or logs.

The operating status of items and/or equipment is identified through records, checklists, or operational tagging systems that are maintained to indicate the status and authority to operate the item and/or equipment and is not generally applicable to the ESP application development.

Testing to support the ESP project is controlled by specific test procedures that assure that all evolutions are controlled.

The application and removal of the various status tags, stickers, and other indicators is controlled by Station Procedures.

16. Nonconforming Materials, Parts, or Components

A documented system for controlling non-conformances observed during receipt inspection, storage, fabrication and erection, installation, initial and/or acceptance testing, or initial operation is established and provides for the preparation, issuing, and distribution of Deviation Reports and Discrepant Shipment Reports in accordance with prescribed procedures.

Due to the scope of the ESP application development project, no parts or materials are expected to be received from offsite sources. This section governs soil and site characterization samples and their storage and shipment (if necessary).

Specifically, instructions require that the individual discovering a non-conformance identifies, describes, and documents the non-conformance on a Deviation Report or a Discrepant Shipment Report in accordance with administrative procedures.

When a non-conforming item is identified, it is placed in the hold area established in the storeroom or other segregated location, if practical, and identified with a hold tag to prevent its inadvertent use. If material is dispositioned as “reject” the hold tag shall remain attached to the material/component until loaded for departure from site and shall only be removed in accordance with approved procedures by authorized personnel at that time.

Hold items may be released on a risk basis following the documented approval of such risk release by the Site Vice President on a Release on a Risk Basis Form. Each risk release is handled on a case basis and depends on the nature of the hold status. The basis and conditions of the release are described on the form, including the criteria for clearing the original hold status.

Rejected material is not risk released.

A Deviation Report or a Discrepant Shipment Report for a non-conforming material, part, or component dispositioned “accept as is” requires an engineering analysis and approval. The results of this review and approval are documented and become a part of station records.

Should the disposition of a non-conformance require the rework or repair of materials, parts, components, systems, or structures, such rework or repair is reinspected or retested by a method which is at least equal to the original inspection or test method. The inspection requirements and the inspection, rework, or repair procedures are documented and become a part of station records.

The disposition and approval of non-conformances are the responsibility of the on-site organization. However, the Site Vice President has the authority to request assistance as appropriate from Corporate support organizations or from Nuclear Oversight.

The Station Deviation Reports trends are periodically reviewed for conditions adverse to quality by station management.

Implementation and verification of the procedures for the control of non-conformances are assured through audits and inspections.

Non-conformances found at a vendor's facility during surveillances are controlled by procedures administered by Nuclear Engineering.

17. Corrective Action

Corrective action measures are established as an integral part of the processing and resolving of non-conformances and failures in service. Through these measures, assurance is confirmed that significant adverse quality conditions are identified, documented, their cause determined, and the corrective actions have been taken that preclude repetition of the adverse quality conditions. Verification of the proper implementation of corrective action measures and close-out of corrective action documentation is assured through the monitoring effort of the staff and the audits conducted by Nuclear Oversight. Adverse conditions significant to quality, the cause of the conditions, and the initiation of corrective action are reported to appropriate levels of both offsite and onsite management by use of Deviation Reports and audit findings. If further corrective action is required the appropriate management program for performing, tracking and closing the issue will be used.

Nuclear Engineering maintains a program to evaluate complex design concerns that may lead to adverse quality conditions at the nuclear stations. The Potential Problem Reporting (PPR) system allows for detailed, multidiscipline reviews of complex design concerns that may yield station deviation reports. Many design concerns cannot be determined to be adverse to quality until a detailed design review is performed. The PPR process controls this activity as part of the Nuclear Design Control Program.

The procedures for processing a Deviation Report require that each adverse condition significant to quality be categorized as either requiring a Licensee Event Report, Special Report or NRC Notification or as a non-reportable deviation. Non-reportable deviation refers to deviations not reportable to the Nuclear Regulatory Commission. The reporting requirements differ for each of the categories of deviation but require the appropriate levels of management be notified in each case.

The corrective action program is controlled in accordance with VEP-1-5A, Operational Quality Assurance Program Topical Report. This program will be used to resolve all corrective action items.

Authority to Stop Work

Nuclear Oversight and inspection personnel have the authority, and the responsibility, to stop work in progress which is not being done in accordance with approved procedures or where safety or equipment integrity may be jeopardized. This extends to off-site work performed by vendors furnishing safety-related materials and services to the Company.

Imposition of "Stop Work"

A. **Nuclear Oversight -** The Nuclear Oversight or inspection representative advises the cognizant supervisor or supervisory personnel to stop work in progress whenever they determine that it is not being conducted in accordance with applicable procedures, instructions, guides, or standards or may jeopardize the safe operation of the station. Nuclear Oversight representatives inform the Director Nuclear Oversight of the stop work order. Inspection personnel inform the Director Nuclear Station S&L of the stop work order. The Director Nuclear Oversight or the Director Nuclear Station S&L then notifies the Vice President Nuclear Support Services of the decision to stop work because of adverse quality conditions.

B. **Vice President Nuclear Support Services -** The Vice President Nuclear Support Services evaluates the determination to stop work.

1. If the Vice President Nuclear Support Services concurs with the decision to stop work, the necessary corrective action is initiated. Only after the discrepancy has been corrected and the corrective action approved by the initiating organization does work resume.

2. In the event the Vice President Nuclear Support Services does not concur with the decision to stop work, direction may be given to resume work by notifying the Director Nuclear Oversight and the appropriate supervisory personnel in the organization of the decision. The issue shall also be referred to the Senior Vice

President - Nuclear Operations and Chief Nuclear Officer for review and approval.

C. **Senior Vice President - Nuclear Operations and Chief Nuclear Officer -** The Senior Vice President - Nuclear Operations and Chief Nuclear Officer is responsible for approving or disapproving the Vice President Nuclear Support Services' decision in those cases where the Senior Vice President - Nuclear Operations and Chief Nuclear Officer does not concur with the decision to resume work following a stop work order.

D. **Director Nuclear Oversight -** The Director Nuclear Oversight may refer any issues concerning the handling of "stop work" to the Senior Vice President and Chief Nuclear Officer. The Director Nuclear Oversight may direct imposition of "stop work" whenever such action is deemed to be appropriate. Imposition of offsite "stop work" performed by vendors shall be controlled by appropriate administrative procedures.

18. Quality Assurance Records

The requirements and responsibilities for quality assurance records transmittal, retention, and maintenance subsequent to completion of work at the power station have been established and are documented in administrative procedures.

VEP-1-5A, Operational Quality Assurance Program Topical Report will govern the requirements and commitments for the retention and storage of Quality Assurance Records.

19. Audits

Internal audits of selected aspects of construction phase activities are performed with a frequency commensurate with safety significance and in a manner which assures that biennial (2 years) audits of safety-related activities are completed. In addition, due to the relatively short nature of the application development process, an audit will be scheduled of the project prior to application submittal. The audits are scheduled on a formal preplanned audit schedule. The audit system is reviewed periodically and revised as necessary to assure coverage commensurate with current and planned activities. Additional audits may be performed as deemed necessary by management. The scope of the audit is determined by the quality status and safety importance of the activities being performed. These audits are conducted by trained personnel not having direct responsibilities in the area being audited and in accordance with preplanned and approved audit plans or checklists.

Nuclear Oversight is delegated the responsibility for conducting periodic internal and external audits. Internal audits are conducted to determine the adequacy of programs and procedures, that they are meaningful, and comply with the overall Quality Assurance Program. External audits determine the adequacy of vendor and contractor 10 CFR 50, Appendix B QA Programs. An audit includes an objective evaluation of quality-related practices, procedures, and instructions; the effectiveness of implementation; and the conformance with policy and directives. An audit also includes the evaluation of work area, activities, processes, and items and the review of documents and records. Provisions are established requiring that audits be performed in those areas where the requirements of Appendix B to 10 CFR 50 are being implemented. These areas include as a minimum, but are not limited to, those activities associated with the preparation, review, approval, and control of design and design changes, procurement documents, instructions, procedures, and drawings; receiving and plant inspections; indoctrination and training programs; and the remaining criteria in Appendix B to 10 CFR 50.

The results of each audit are reported in writing to the Project Manager, the Vice President Nuclear Support Services and the Senior Vice President – Nuclear Operations and Chief Nuclear Officer. Additional internal distribution is made to other concerned management levels in accordance with approved procedures.

Management responds to all audits and initiates corrective action where indicated. Where corrective action measures are indicated, documented follow-up of applicable areas through inspections, review, re-audits, or other appropriate means is conducted to verify implementation of assigned corrective action.

If the Director Nuclear Oversight determines the response to an internal audit finding is unacceptable or if a finding response is not received in the time allotted or if corrective action for a finding is not accomplished as indicated on the response, the matter is brought to the attention of the Vice President Nuclear Support Services or appropriate Corporate Director for resolution. If the Director Nuclear Oversight does not agree with the resolution proposed, the Director of Nuclear Oversight notifies appropriate levels of management in accordance with established escalation procedures. The escalation of external audit issues identified by Nuclear Oversight is controlled by administrative procedures. The responsibility for analyzing audit reports for trends and effectiveness lies with the Director Nuclear Oversight. As trends are discovered or if the effectiveness of the program is in question, the analysis of the Director Nuclear Oversight is forwarded to the management level consistent with the seriousness of the problem.

The Operational Quality Assurance Program Topical Report, VEP-1-5A, Table 17.2-0 contains the standards, requirements or guides from which the procedures implementing this section are based.

20. Issuance and Revision of the Early Site Permit Application Development QA Manual

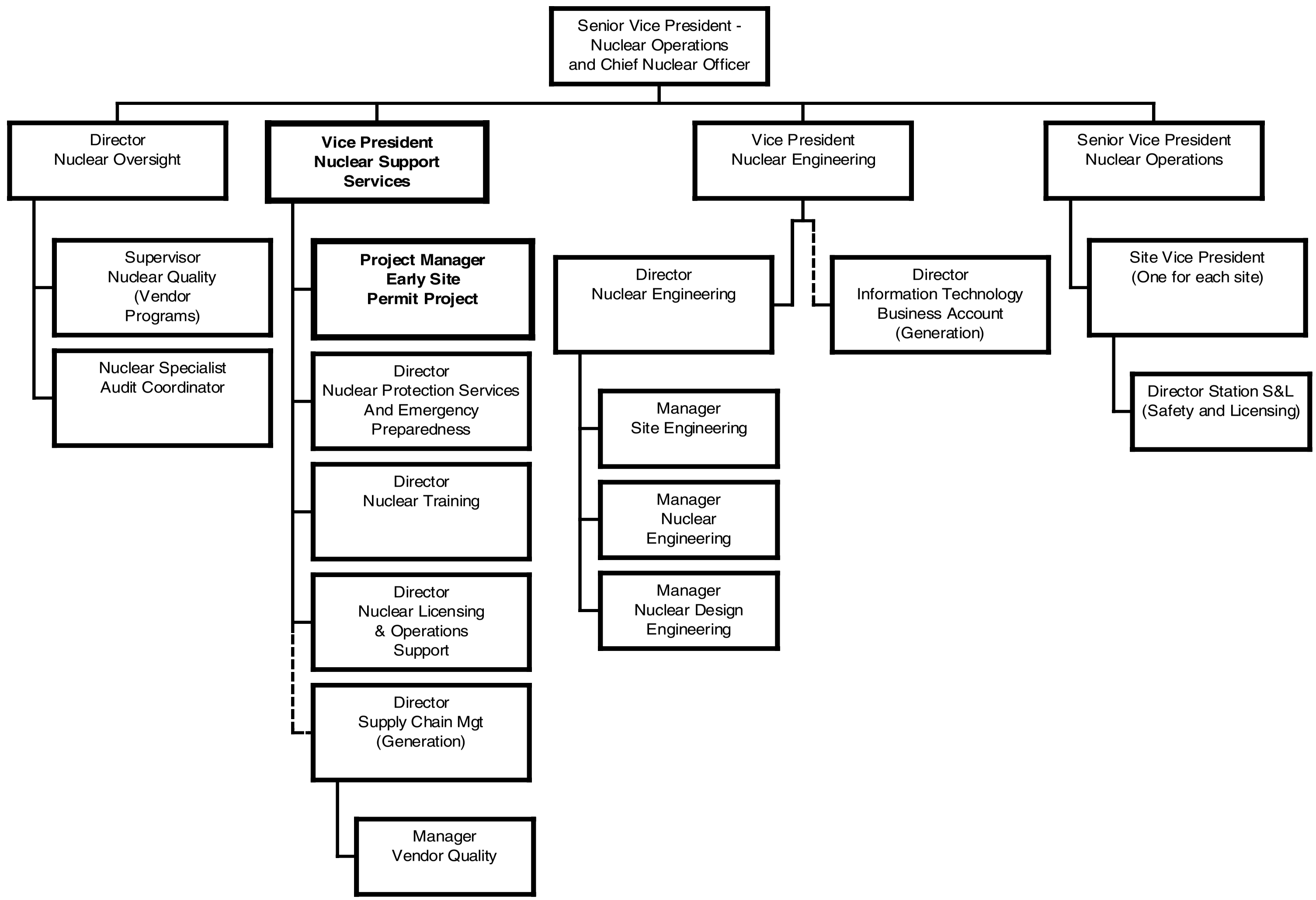
Until the submittal of the Early Site Permit Application, the administrative control of this manual will be the responsibility of the Project Manager – Early Site Permit Project. This manual shall be revised as appropriate to incorporate additional commitments as they are established during the application development process. New revisions to the manual will be reviewed, at a minimum, by the Project Manager - Early Site Permit Project, and the Director of Nuclear Oversight and approved by the Vice President, Nuclear Support Services.

Distribution of this manual will be controlled in accordance with Section 7.

Appendix A

FIGURES

Figure 1
NUCLEAR ORGANIZATION



Appendix B
TABLES

Table 1
Relationship of the Early Site Permit Application Development QA Manual to Appendix B, 10 CFR 50

Appendix B 10 CFR 50 Criterion	QA Manual Section	Title	Abstract
I	2	Organization	Defines the relationship of departments to the quality assurance effort associated with the development of an ESP
II	3	Quality Assurance Program	Defines the Construction Quality Assurance program, its overall responsibility and provisions.
III	4	Design Control	Defines the policy, responsibility and procedures for exercising design control
IV	5	Procurement Document Control	Establishes the policy for procurement control
V	6	Instructions, Procedures and Drawings	Establishes guidelines for preparing instructions, procedures and drawings
VI	7	Document Control	Establishes policy for control of procedures, documents and instructions
VII	8	Control of Purchased Material, Equipment and Services	Establishes methods for assuring that purchased items conform to the specified quality requirements
VIII	9	Identification and Control of Material, Parts and Components	Not applicable to ESP Development
IX	10	Control of Special Processes	Not applicable to ESP Development
X	11	Inspection	Establishes a program for inspection activities affecting quality

Table 1 (continued)

Relationship of the Early Site Permit Application Development QA Manual to Appendix B, 10 CFR 50

Appendix B 10 CFR 50 Criterion	QA Manual Section	Title	Abstract
XI	12	Test Control	Establishes a program to control testing through written test procedures
XII	13	Control of Measuring and Test Equipment	Establishes a policy for control and calibration of test and measuring equipment
XIII	14	Handling, Storage and Shipment	Establishes policy for this function as related to material and equipment.
XIV	15	Inspection, Test, and Operating Status	Makes reference to appropriate administrative procedures which govern this function.
XV	16	Non-Conforming Material, Parts and Services	Establishes policy for reporting and controlling non-conforming materials, parts, or components.
XVI	17	Corrective Action	Establishes the policy for identifying, documenting, notifying, determining causes and preventing defects from occurring
XVII	18	Quality Assurance Records	Assures maintenance, identification, and retrieveability of records
XVIII	19	Audits	Defines policy and procedures for audit programs