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]

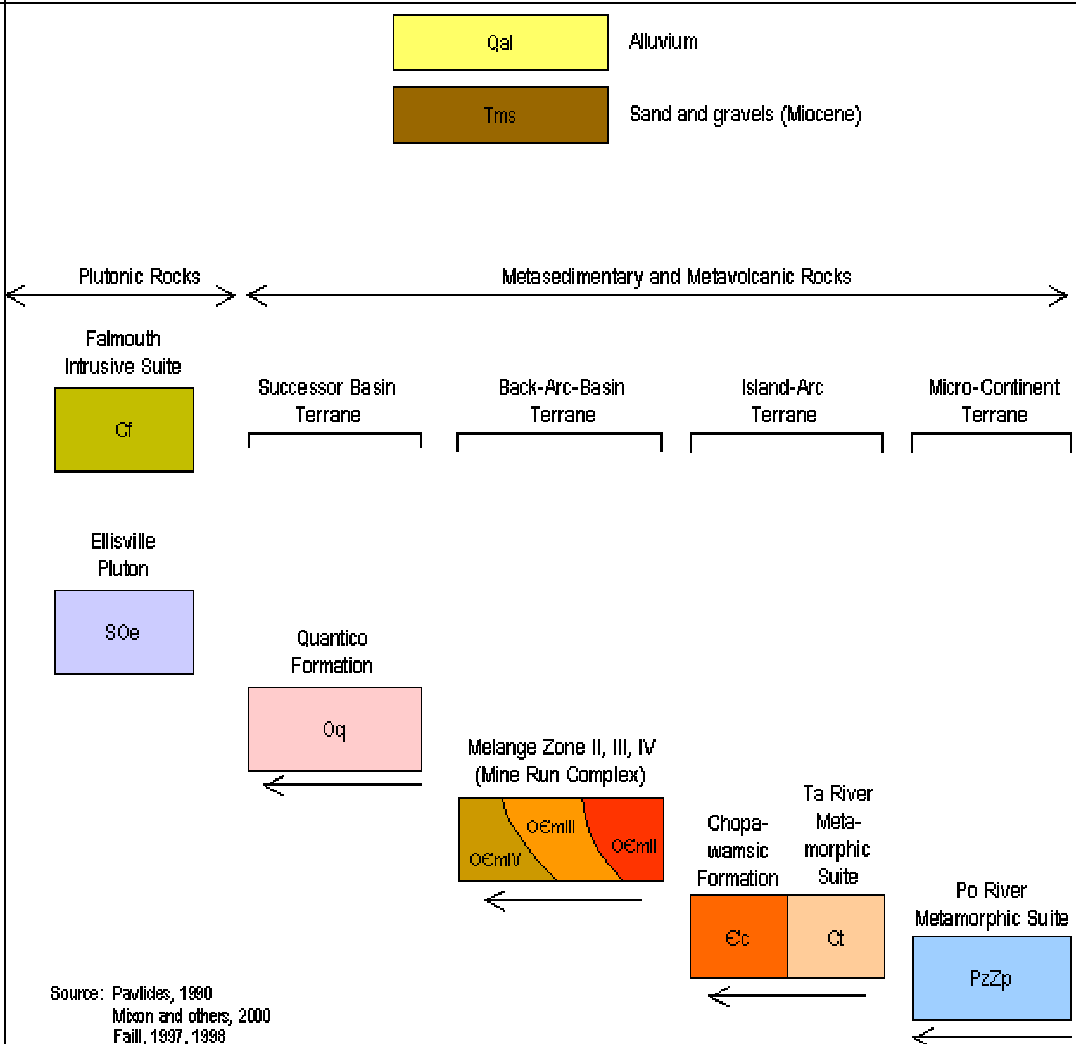
a. NA: Not Applicable

b. NR: Not Reported

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

ERA	AGE (Ma)	PERIOD	OROGENIC EVENT
Cenozoic	2	Quaternary	Cenozoic Erosion
	65	Tertiary	
Mesozoic	250	Cretaceous ↑ Triassic	Extensional Episode
Paleozoic	290	Permian	Allegheny Orogeny
	360	Carboniferous	
	410	Devonian	Acadian Orogeny
	440	Silurian	
	505	Ordovician	Taconic Orogeny
		Cambrian To Ordovician	Penobscot Orogeny
	590	Cambrian and/or Ordovician	Extensional Episode
Pre-Cambrian	900	Late	Grenville Orogeny

CORRELATION OF MAP UNITS (5-Mile Radius)



Source: Pavlides, 1990
Mixon and others, 2000
Faill, 1997, 1998

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)	(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	$\mathbf{M}$[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

Depth, ft	V_s, ft/sec	Profile 1		Profile 2	Profile 3	V_s, ft/sec	Profile 4
		G_{max}	150% G_{max}				
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.

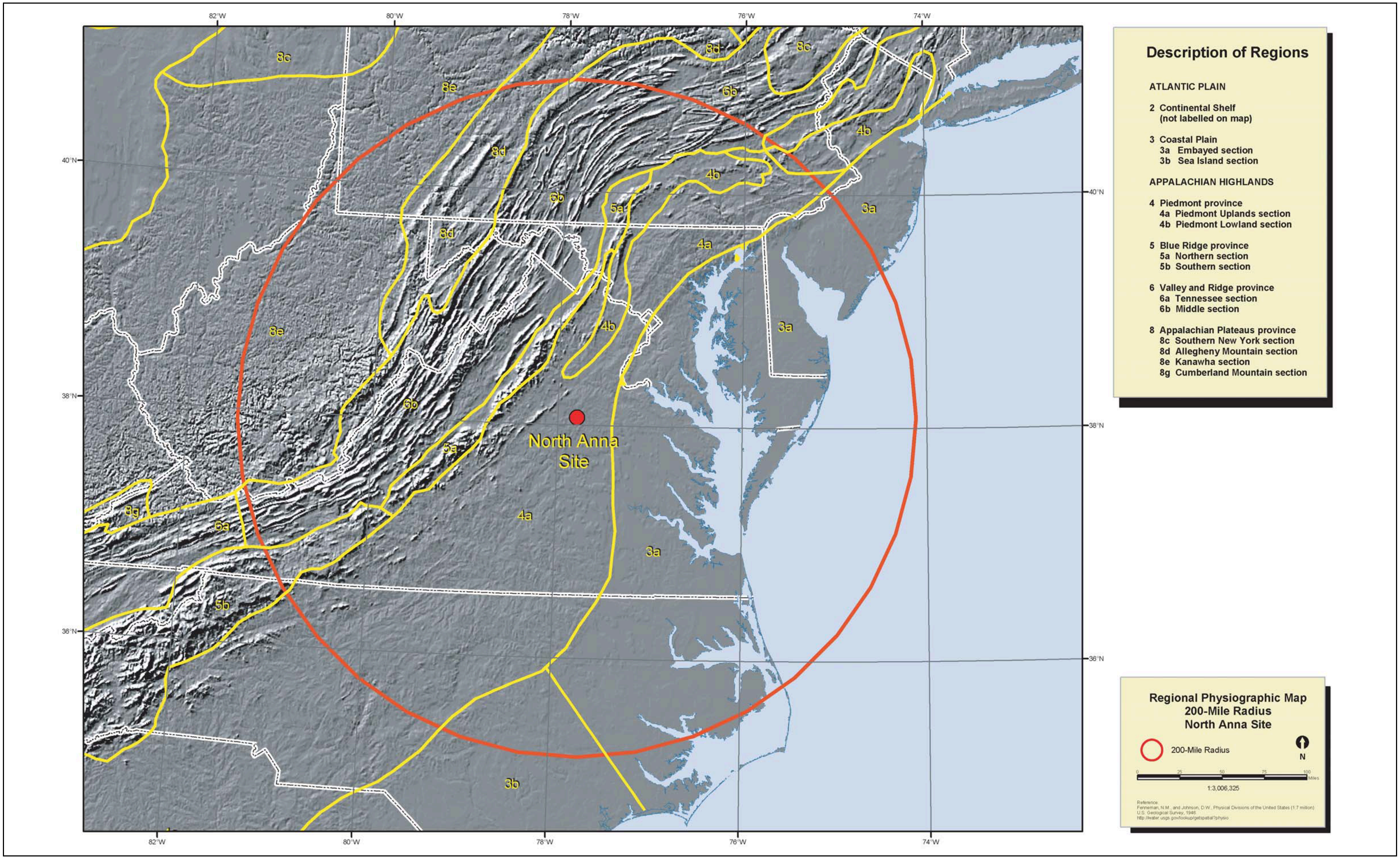


Figure 2.5-1 Regional Physiographic Map (200-Mile Radius)

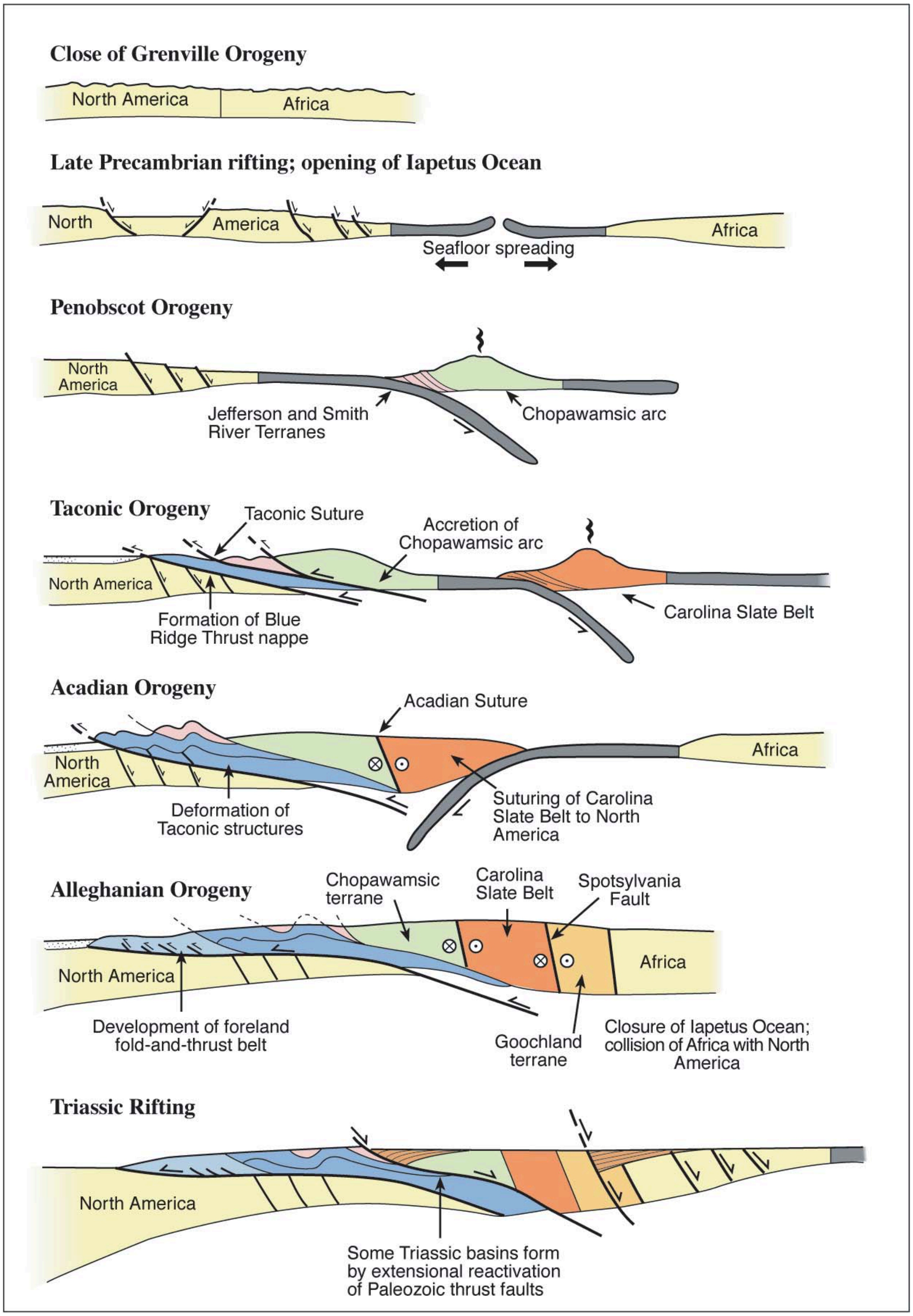


Figure 2.5-2 Evolution of the Appalachian Orogen (after Hatcher, 1987)

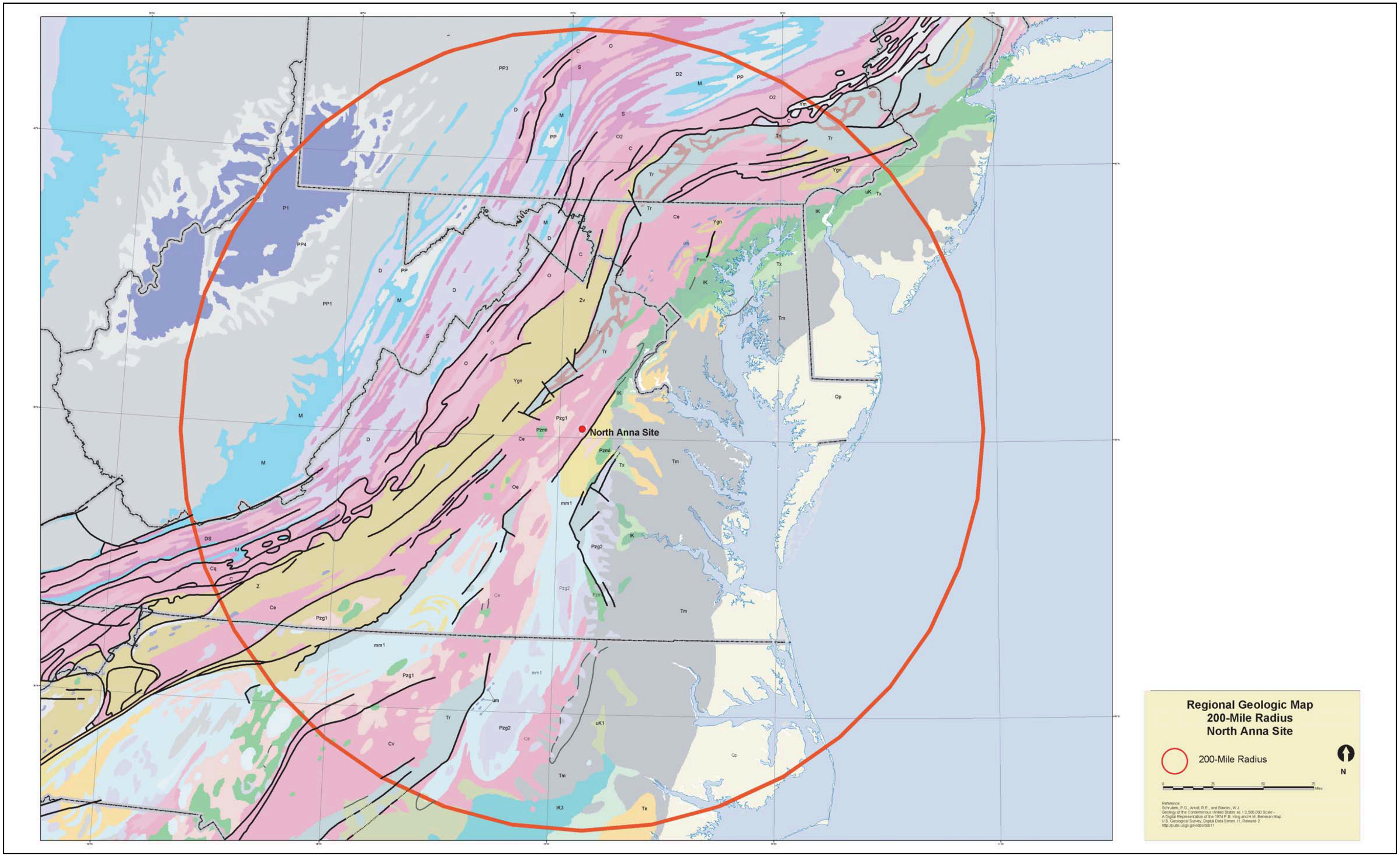


Figure 2.5-3 Regional Geologic Map (200-Mile Radius) (Sheet 1 of 2)

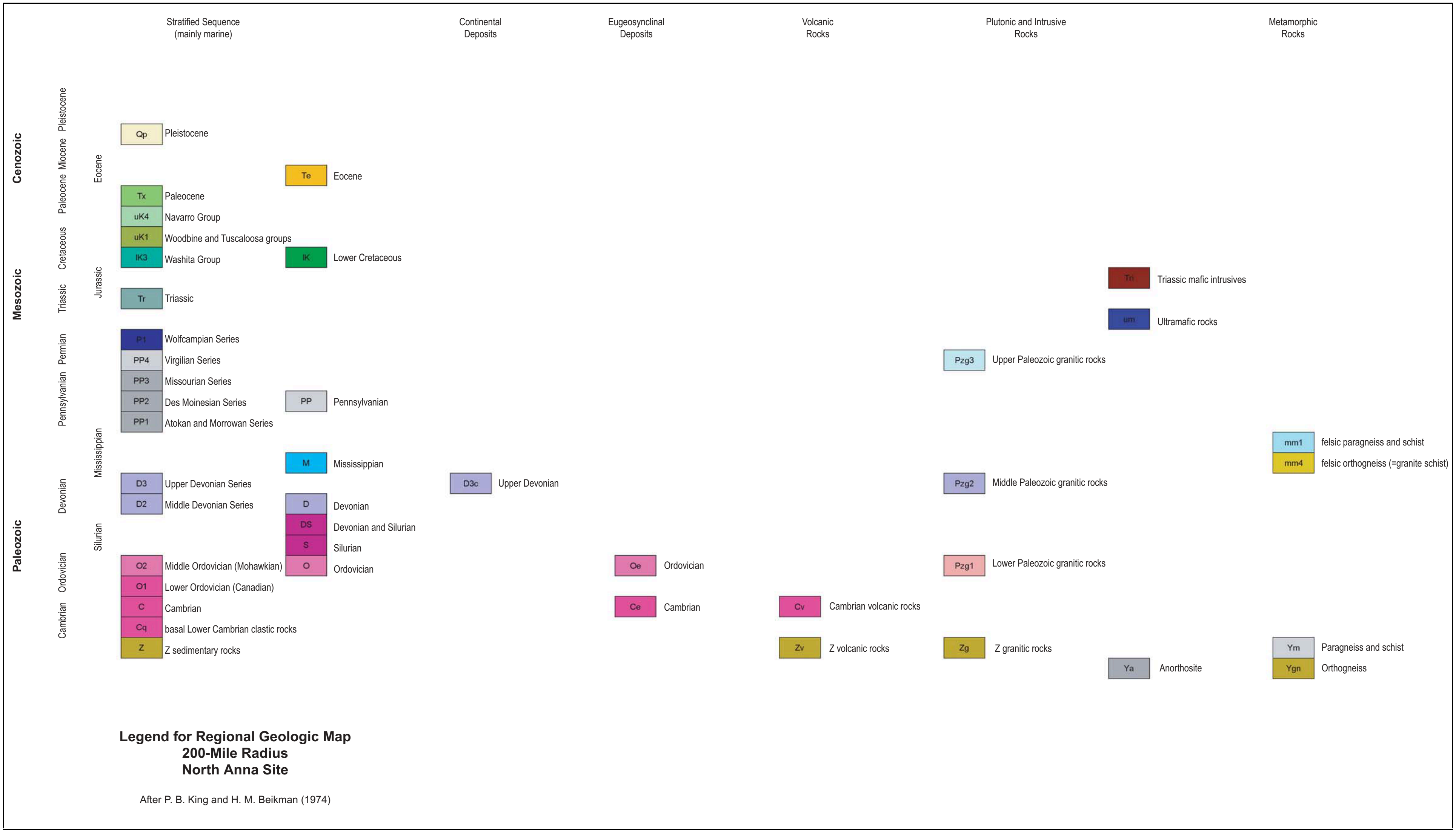


Figure 2.5-3 Regional Geologic Map (200-Mile Radius) (Sheet 2 of 2)

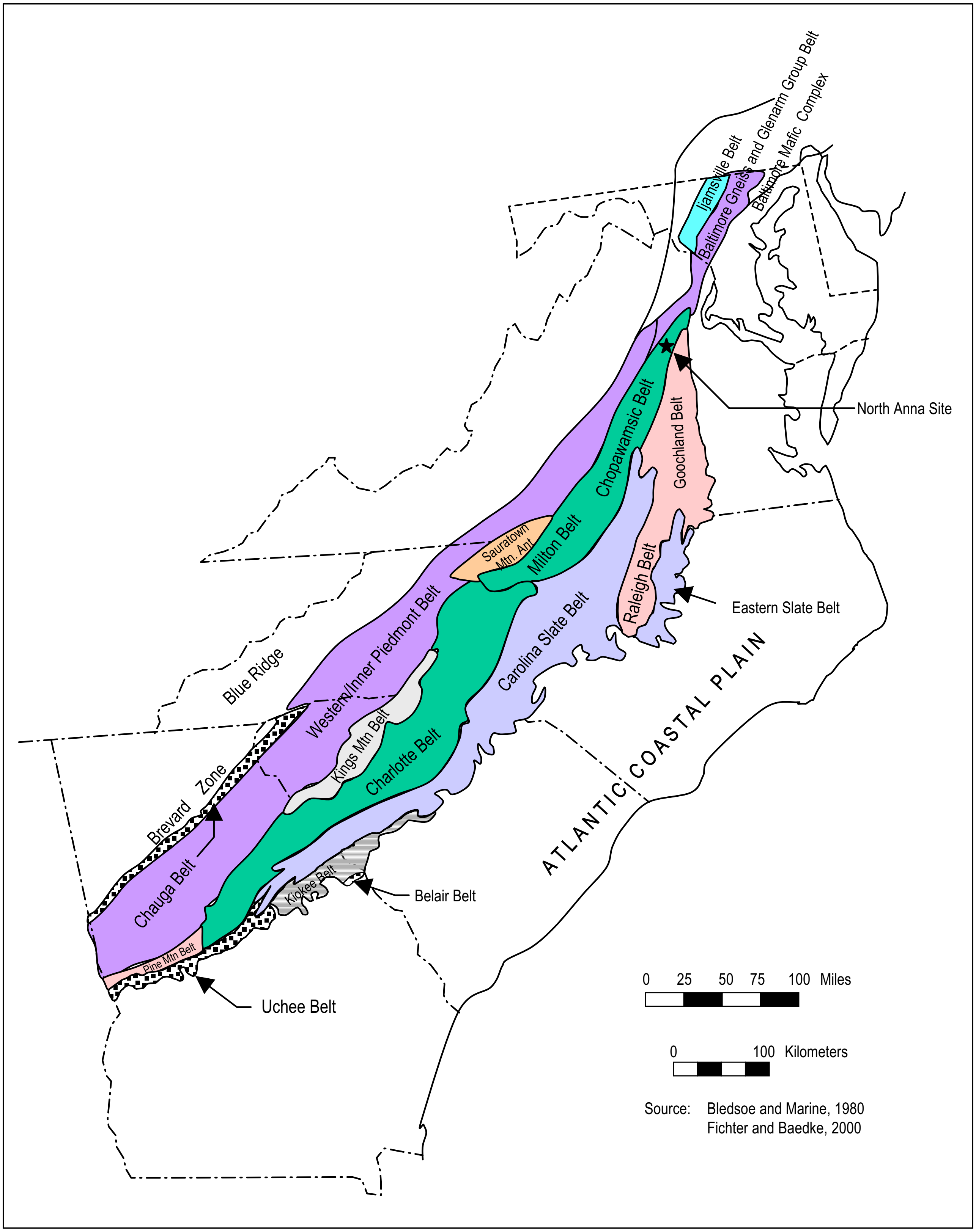


Figure 2.5-4 Lithotectonic Belts of the Piedmont Province

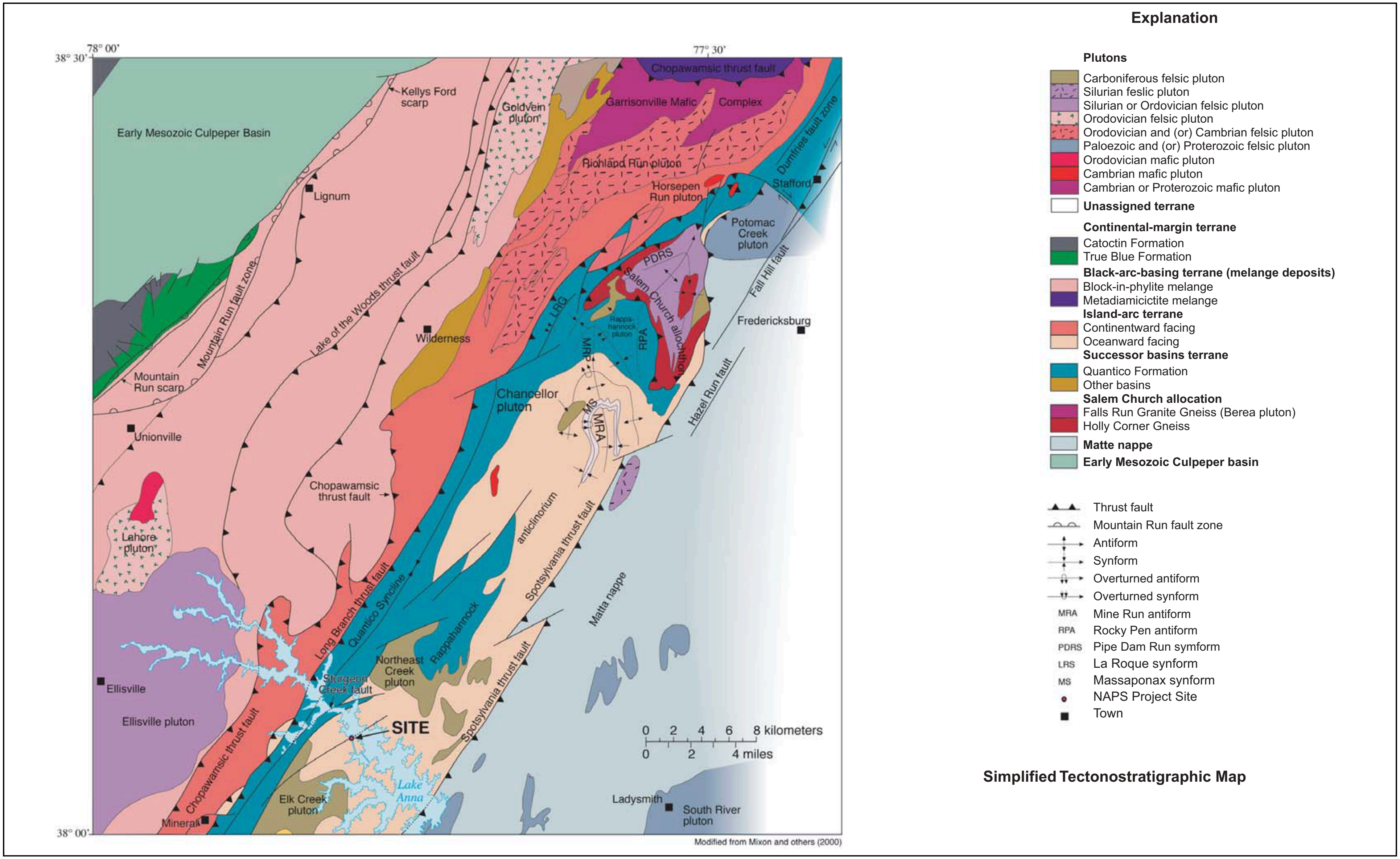


Figure 2.5-5 Simplified Tectonostratigraphic Map

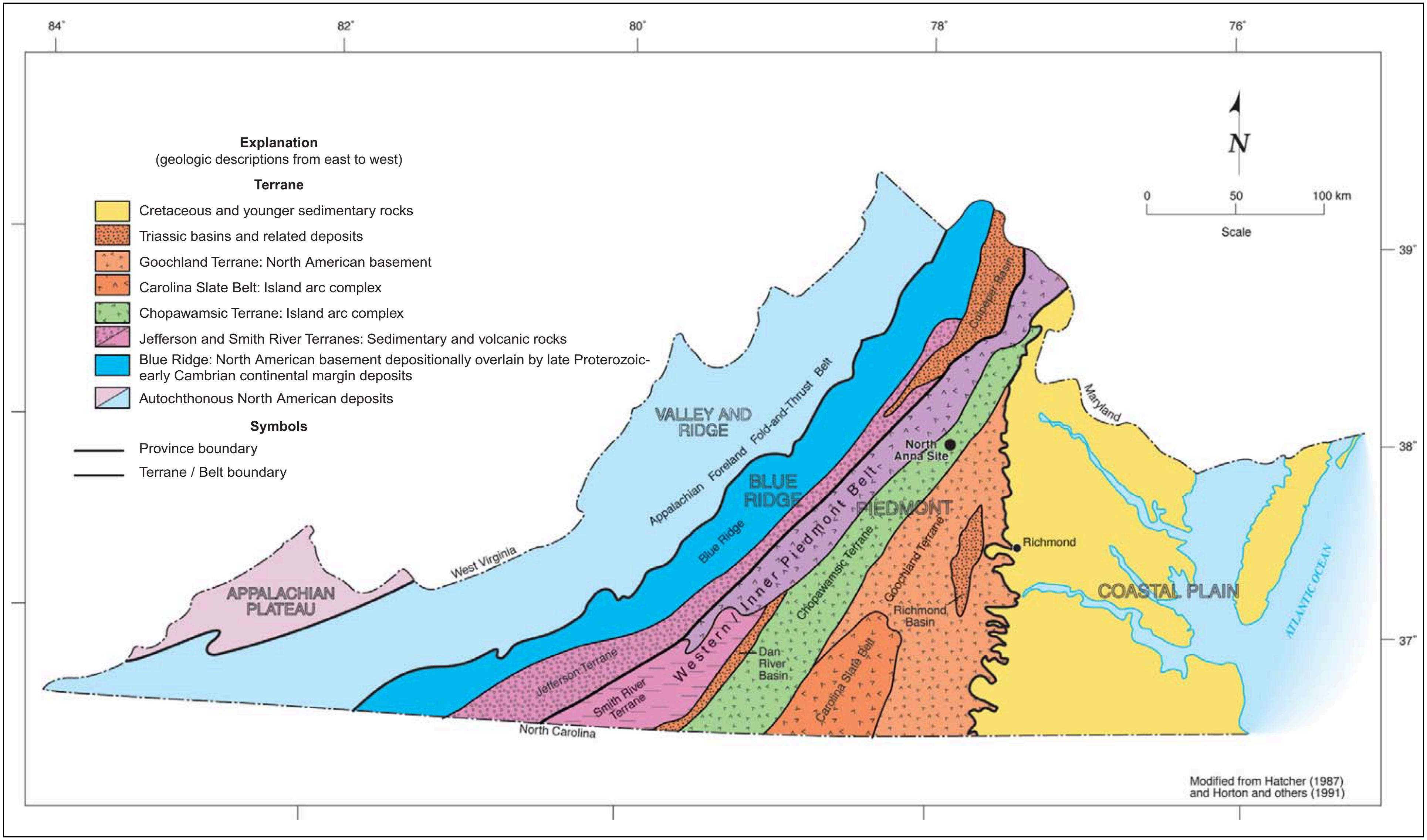


Figure 2.5-6 Simplified Tectonic Map of Virginia

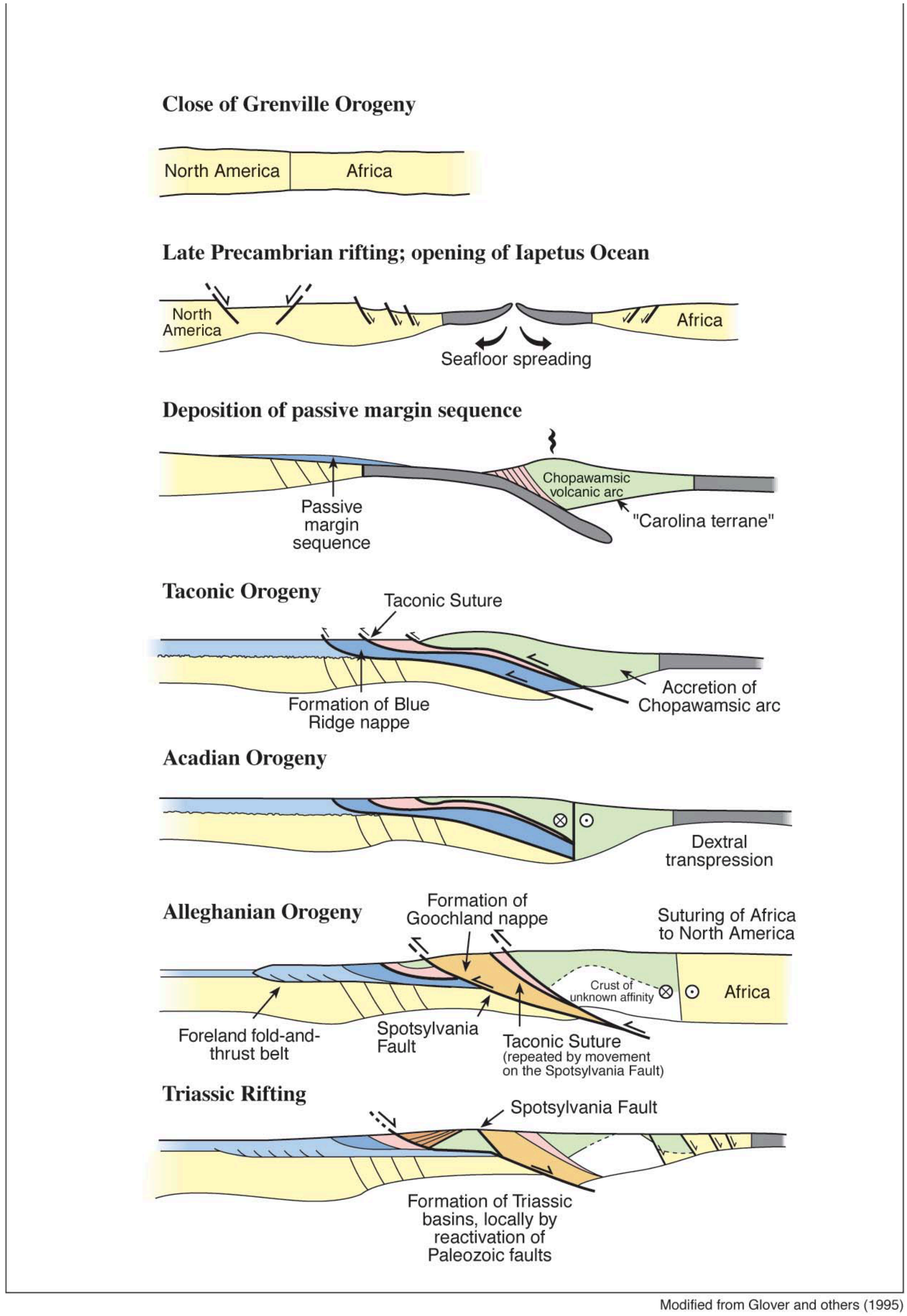


Figure 2.5-7 Evolution of the Appalachian Orogen (after Glover and others, 1995)

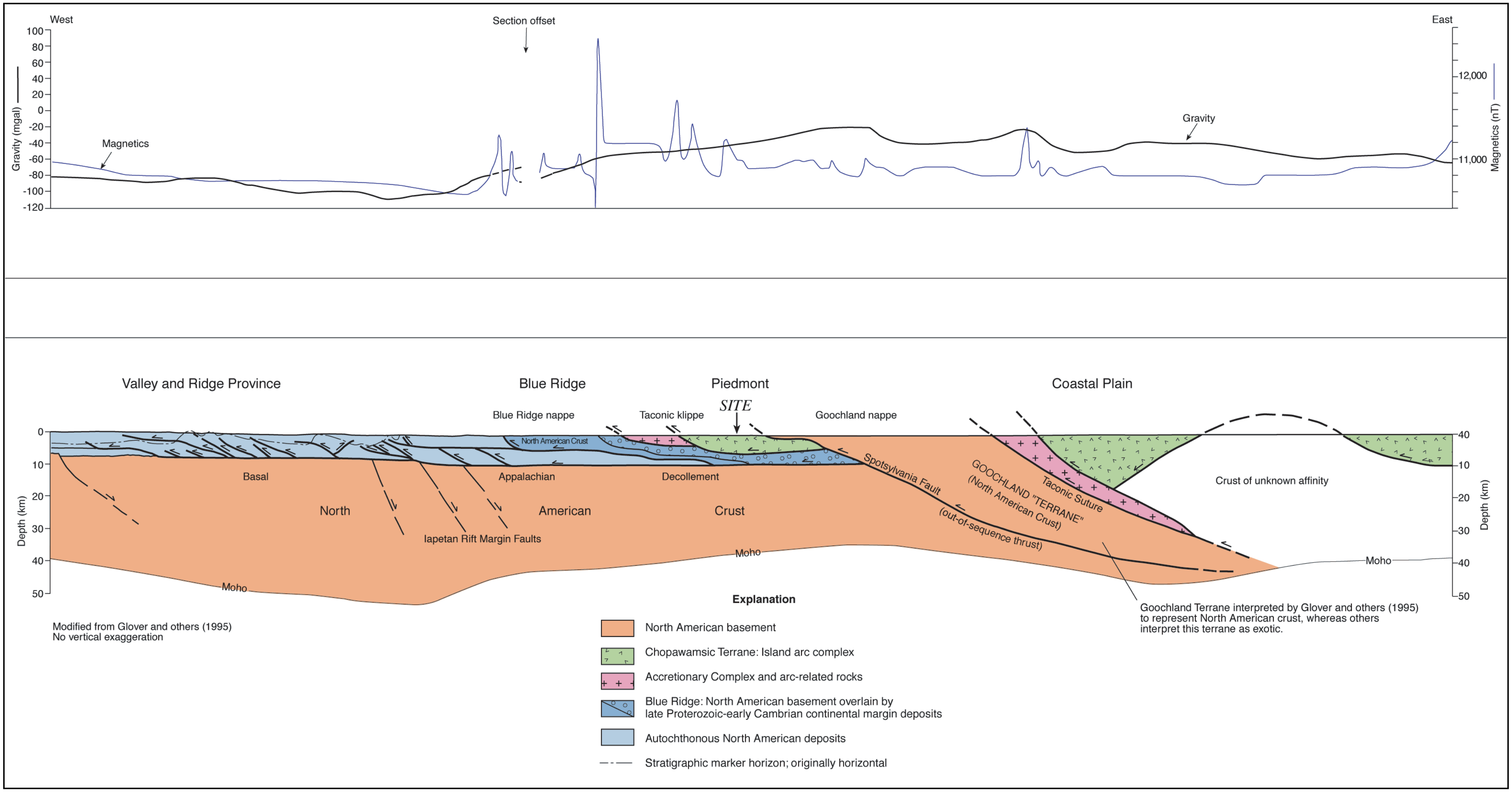


Figure 2.5-8 Crustal Section Through Appalachian Orogen (200-mile radius)

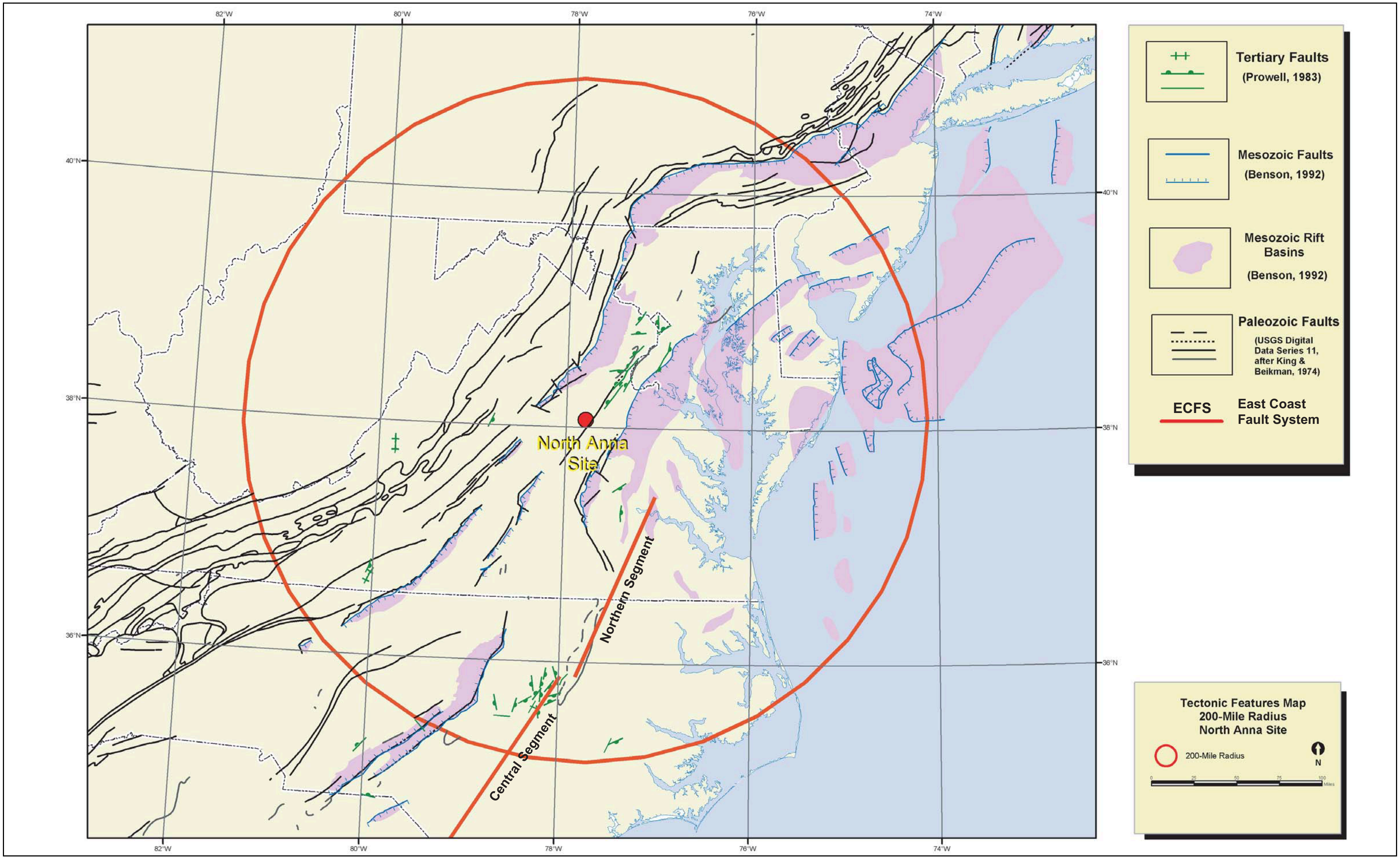


Figure 2.5-9 Tectonic Features Map (200-mile radius)

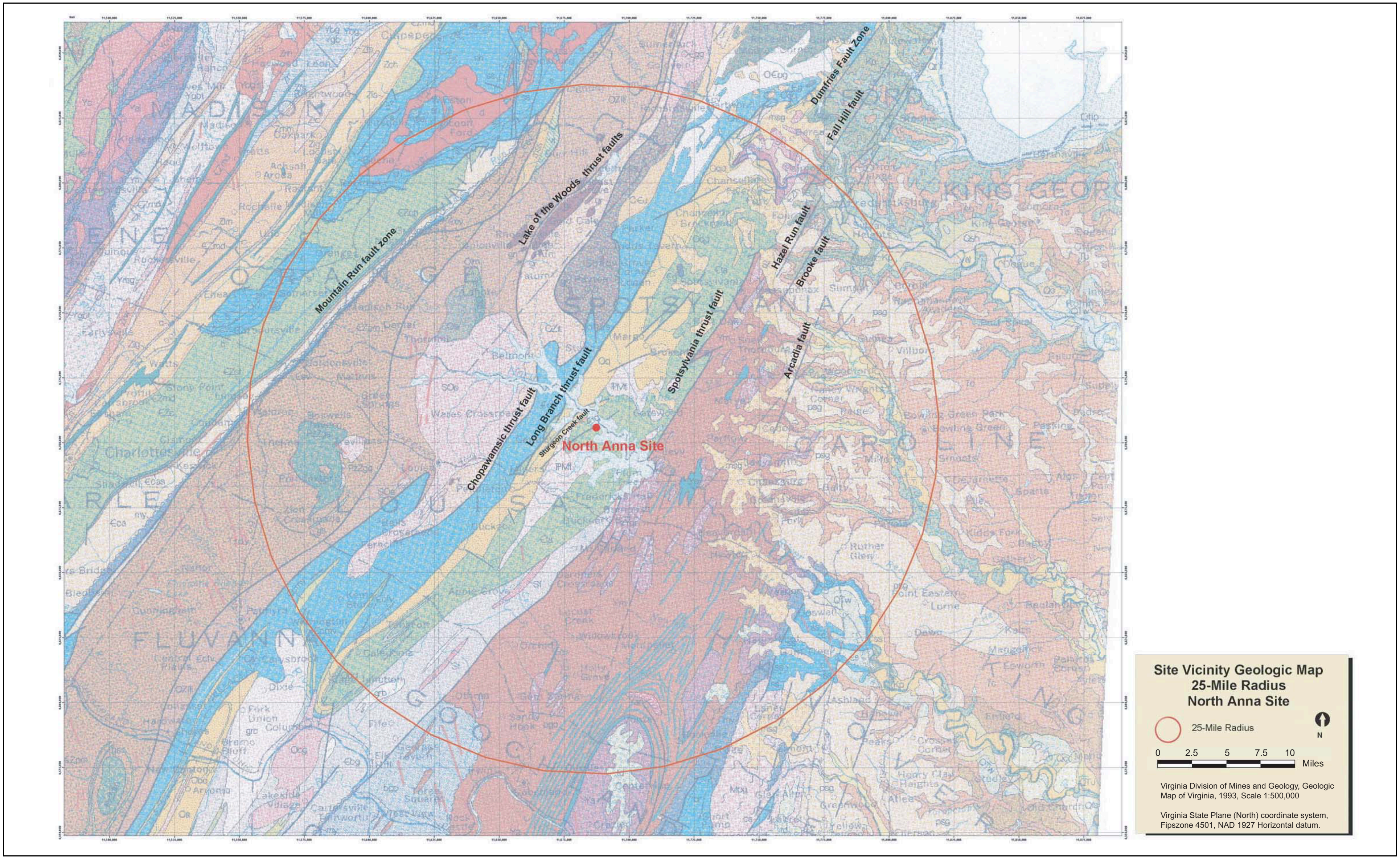


Figure 2.5-10 Site Vicinity Geologic Map (25-Mile Radius) (Sheet 1 of 2)

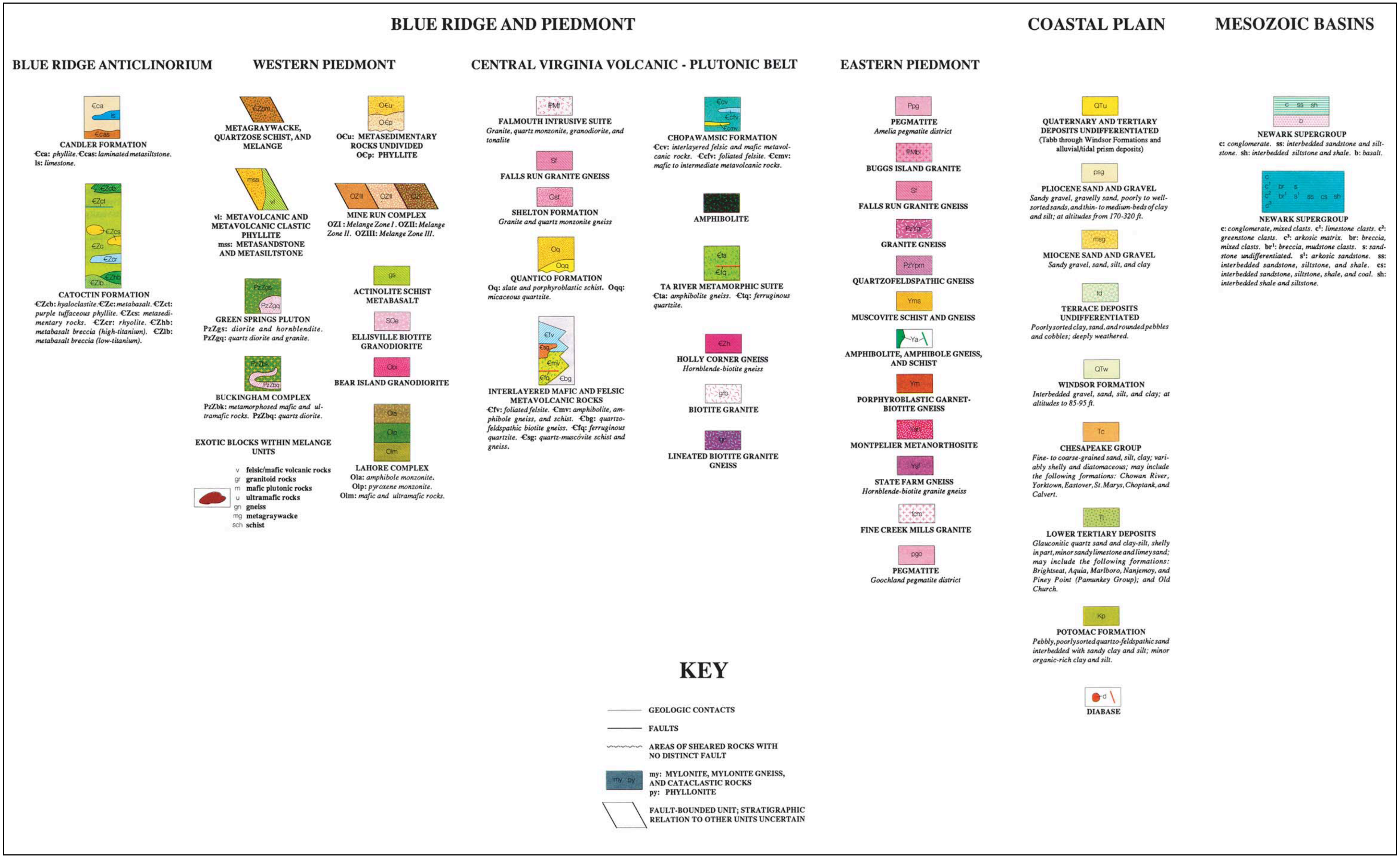


Figure 2.5-10 Site Vicinity Geologic Map (25-Mile Radius) (Sheet 2 of 2)

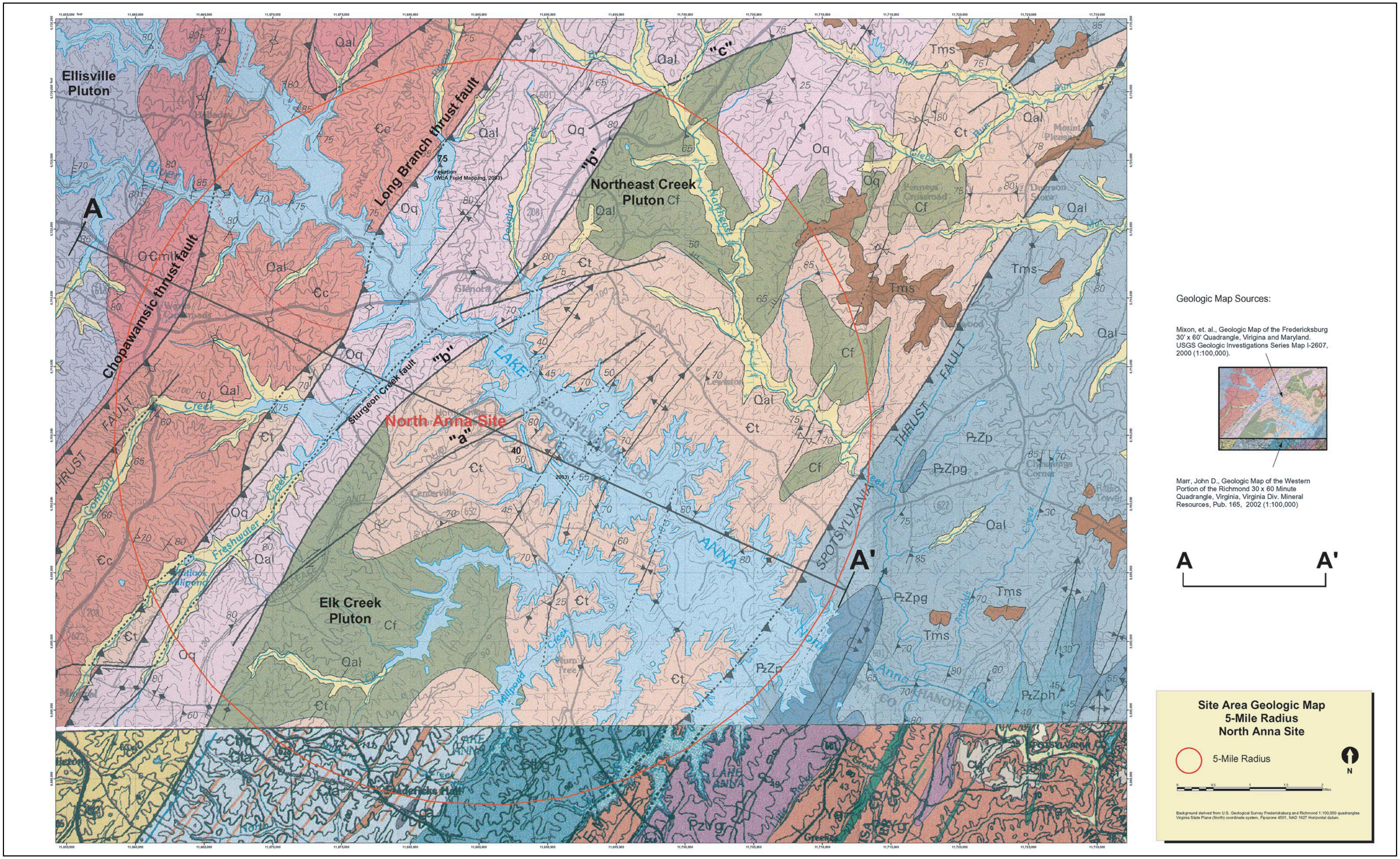


Figure 2.5-11 Site Area Geologic Map (5-Mile Radius) (Sheet 1 of 2)

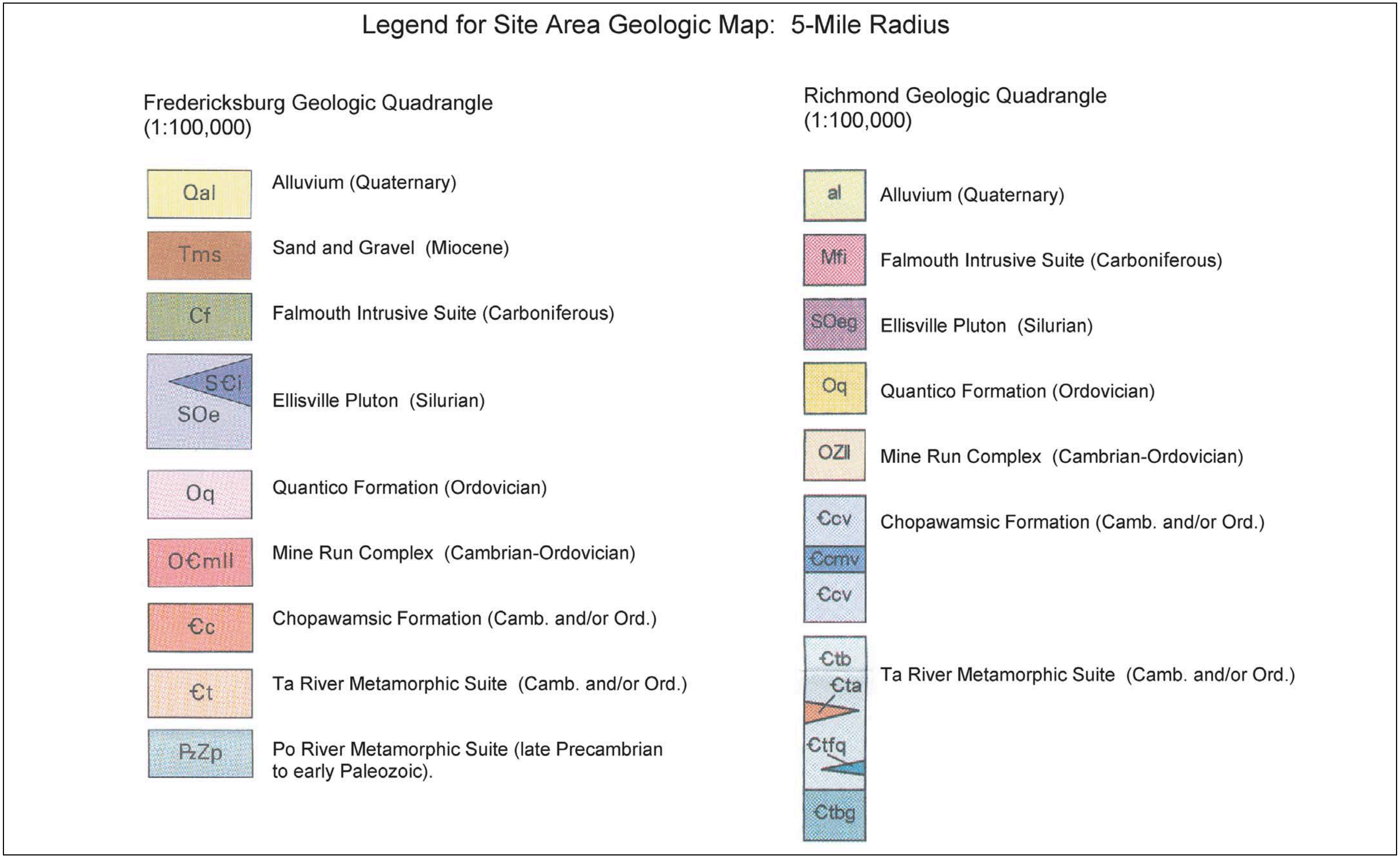


Figure 2.5-11 Site Area Geologic Map (5-Mile Radius) (Sheet 2 of 2)

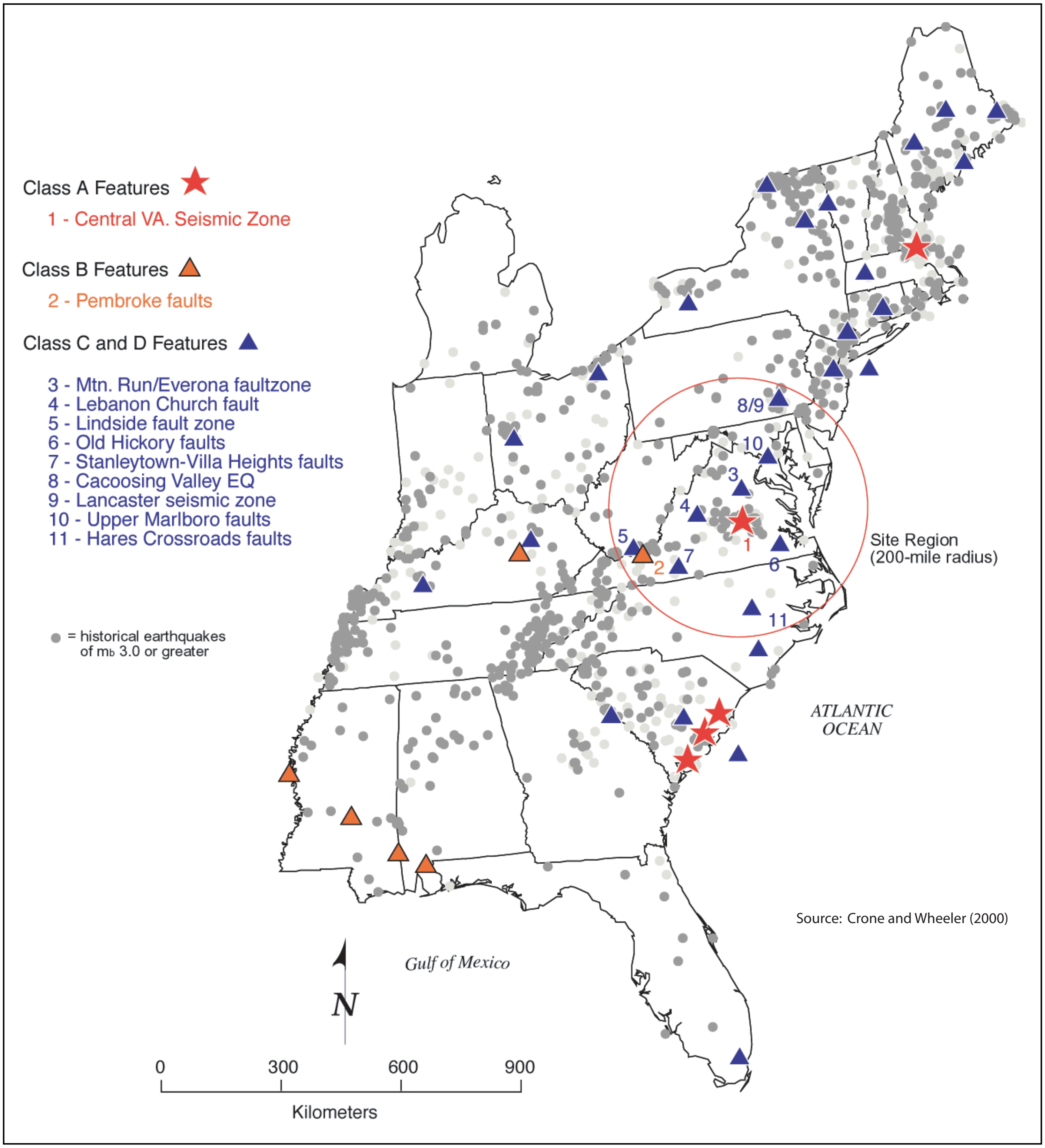


Figure 2.5-12 Quaternary Features Map

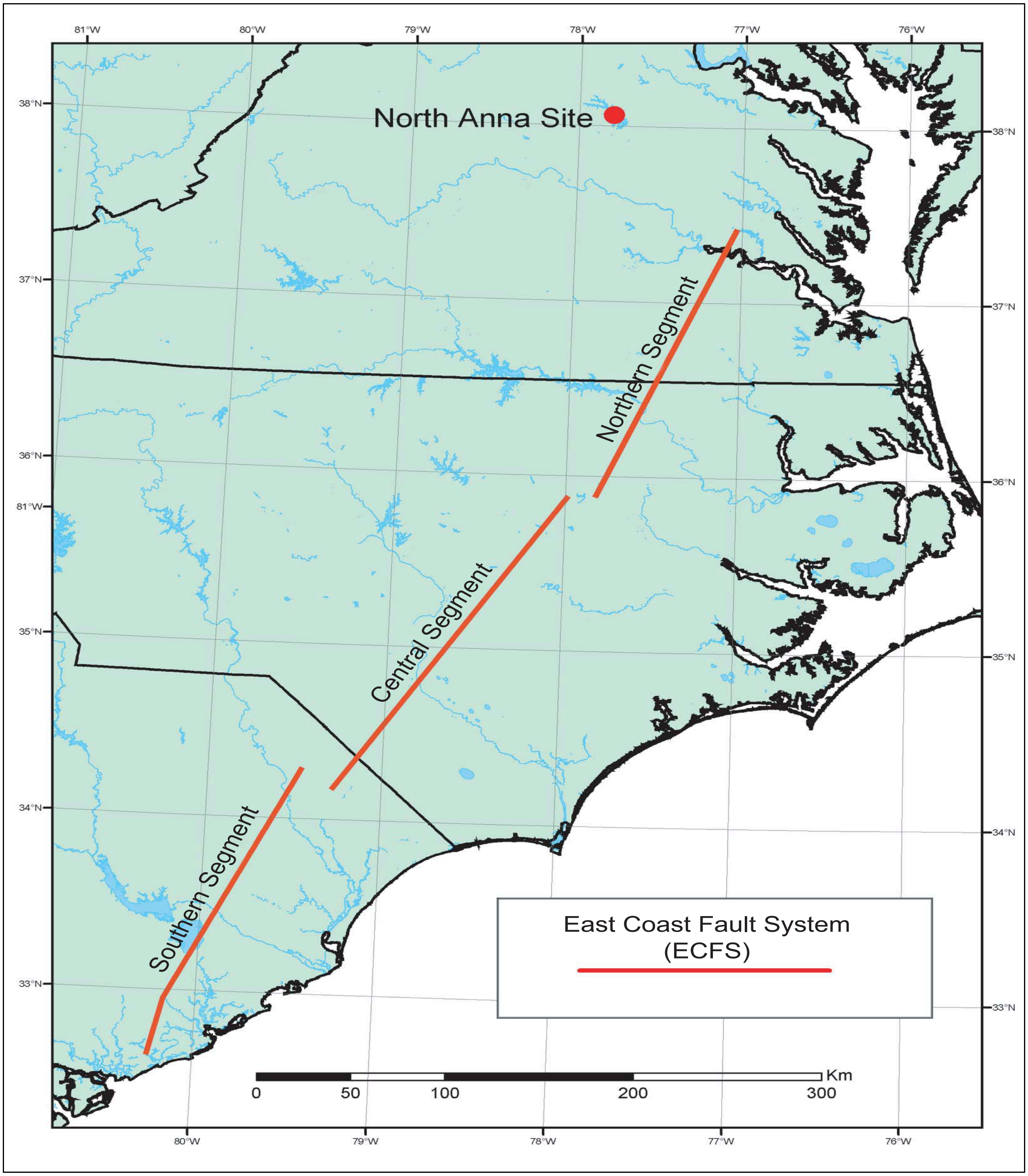


Figure 2.5-13 Northern, Central, and Southern Segments of the East Coast Fault System

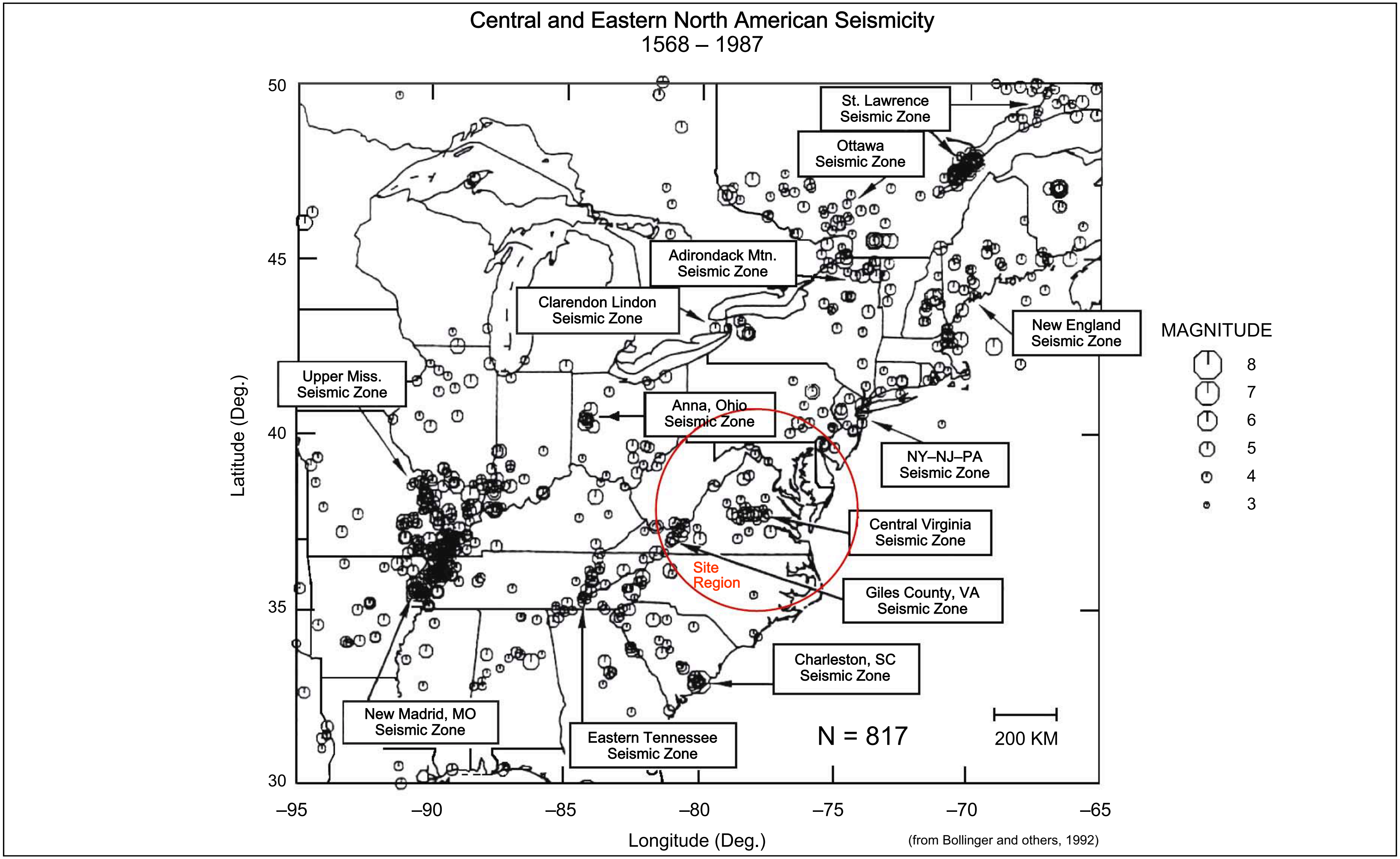


Figure 2.5-14 Seismic Source Zones and Seismicity in Central and Eastern North America