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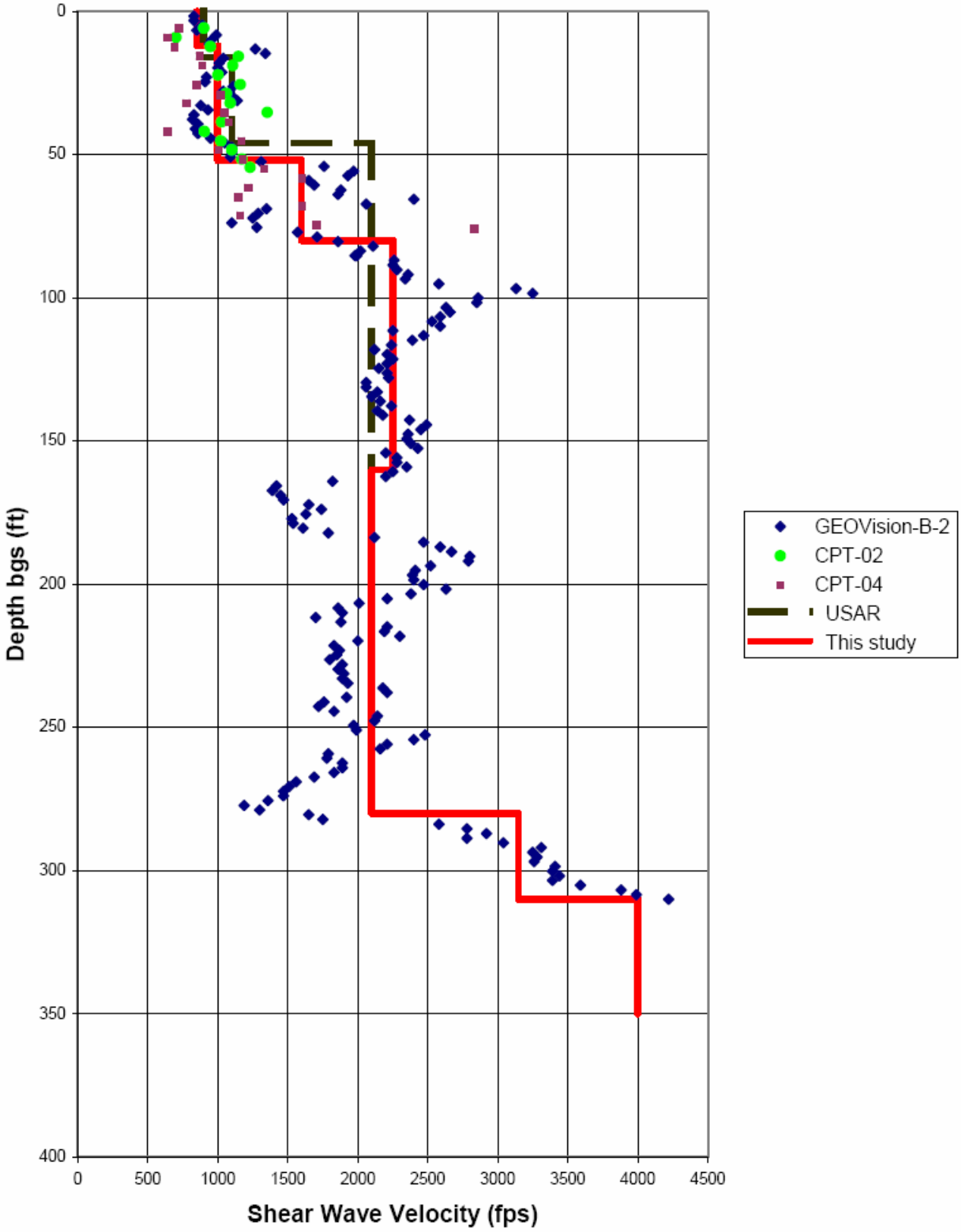
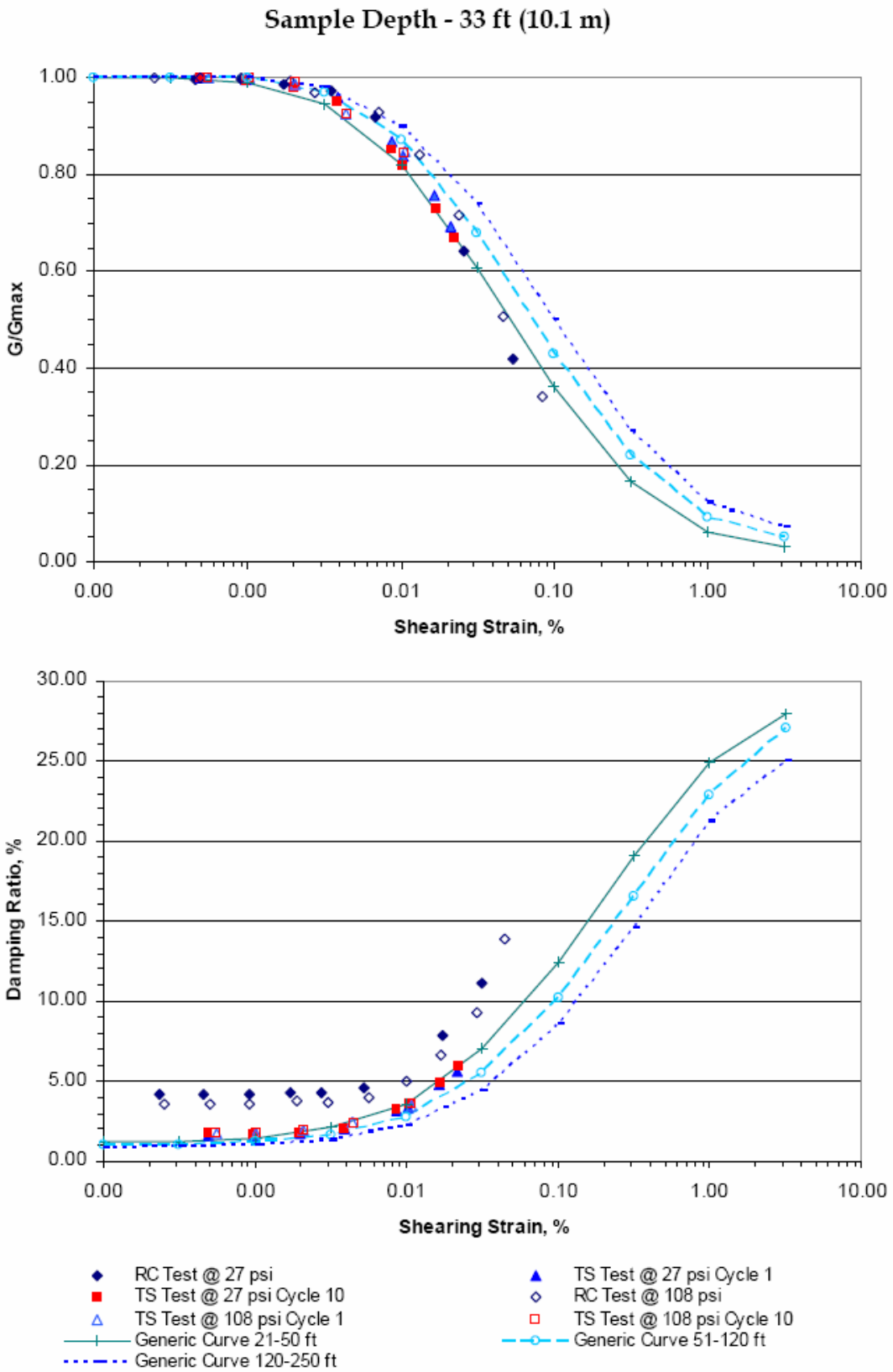


Seismic Hazards Report for the EGC ESP Site

Shear Wave Velocity Data Median Profile for Soils

Figure
4.2-1

Non-GDS

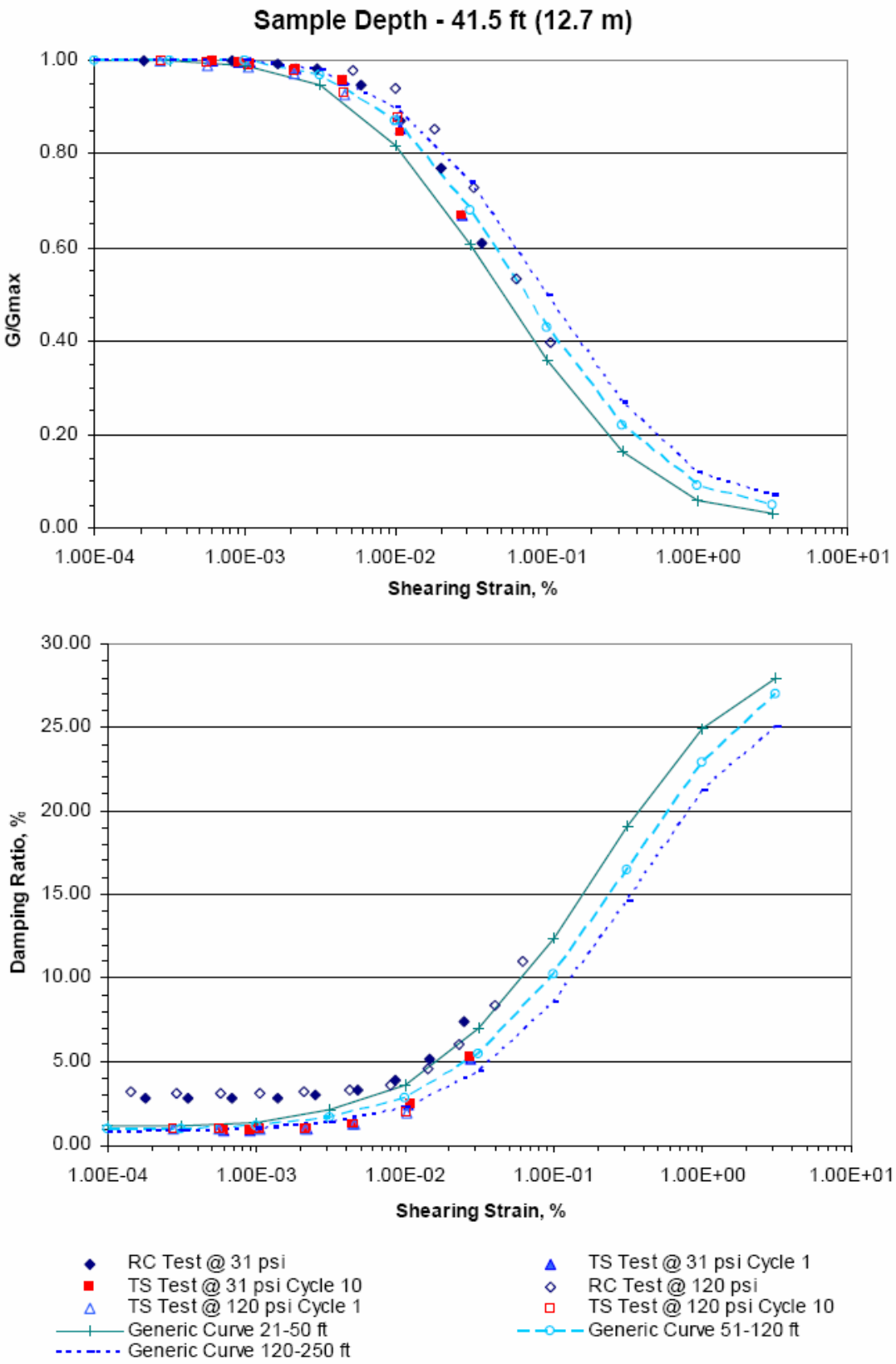


Seismic Hazards Report for the EGC ESP Site

Modulus Reduction and Damping Test Results Compared to EPRI (1993) Soil Property Curves for Test UTA-34-A

Figure **4.2-2**

Non-GDS

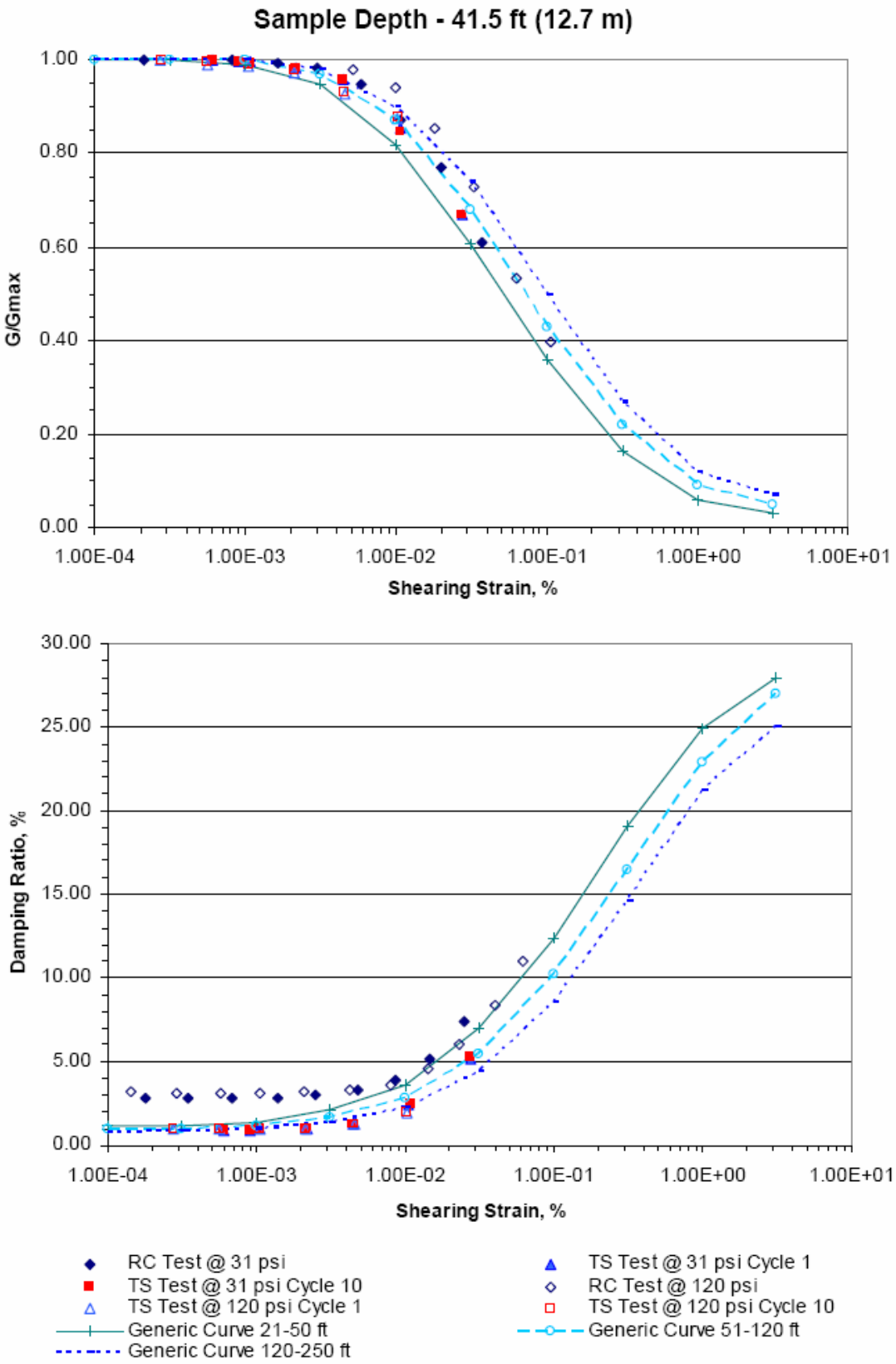


Seismic Hazards Report for the EGC ESP Site

Modulus Reduction and Damping Test Results Compared to EPRI (1993) Soil Property Curves for Test UTA-34-B

Figure **4.2-3**

Non-GDS

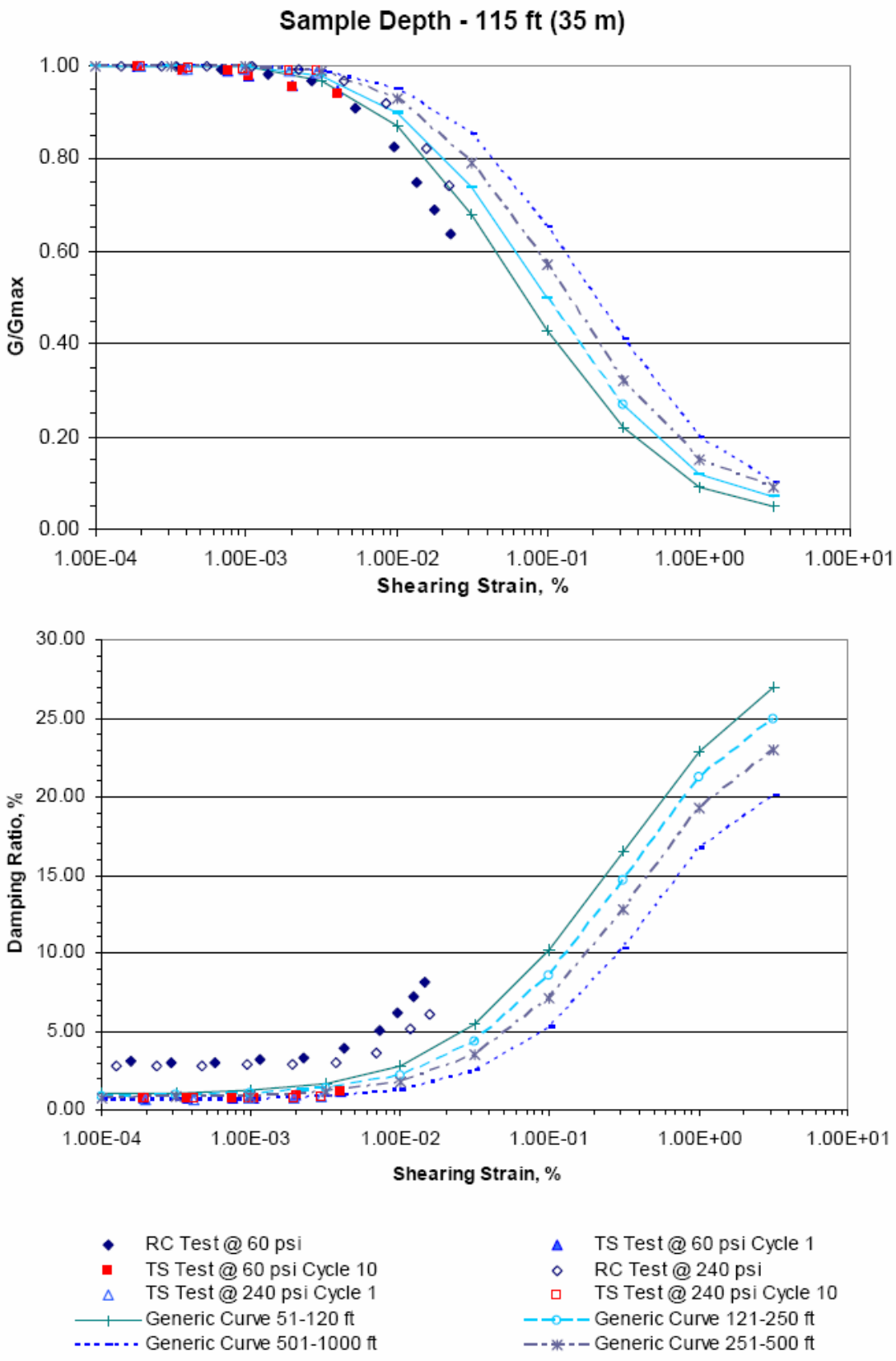


Seismic Hazards Report for the EGC ESP Site

Modulus Reduction and Damping Test Results Compared to EPRI (1993) Soil Property Curves for Test UTA-34-C

Figure **4.2-4**

Non-GDS

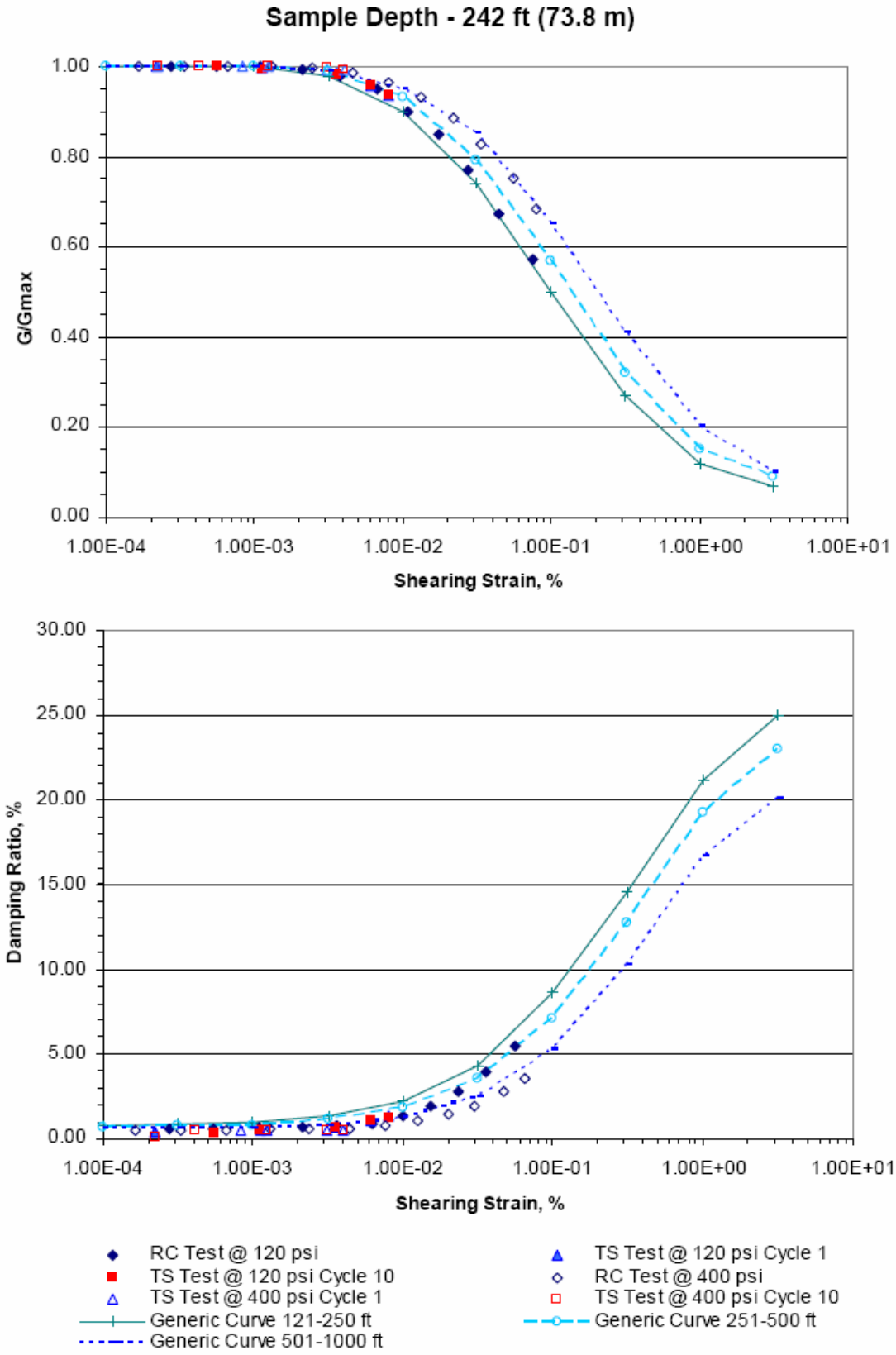


Seismic Hazards Report for the EGC ESP Site

Modulus Reduction and Damping Test Results Compared to EPRI (1993) Soil Property Curves for Test UTA-34-D

Figure **4.2-5**

Non-GDS

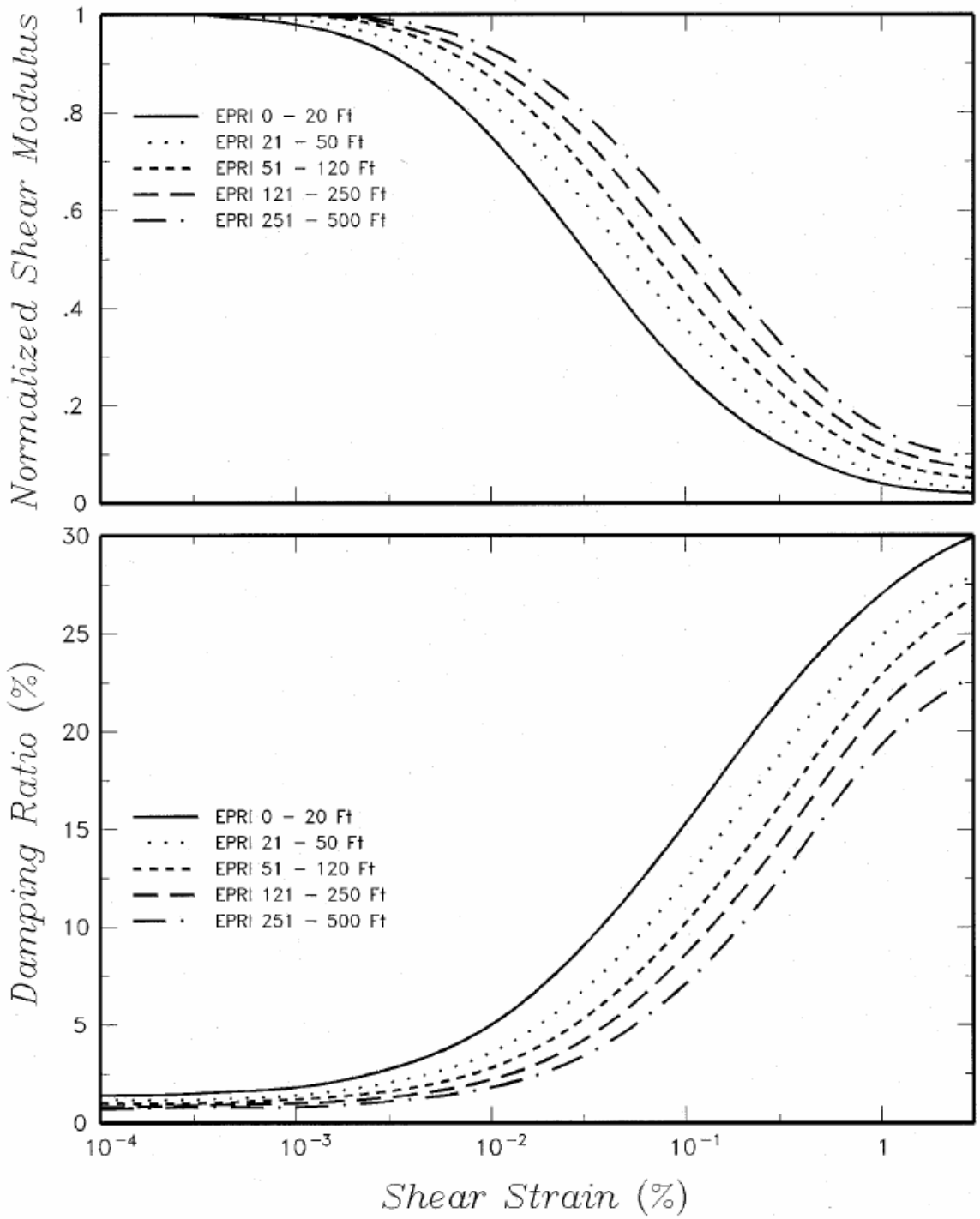


Seismic Hazards Report for the EGC ESP Site

Modulus Reduction and Damping Test Results Compared to EPRI (1993) Soil Property Curves for Test UTA-34-F

Figure **4.2-6**

Non-GDS

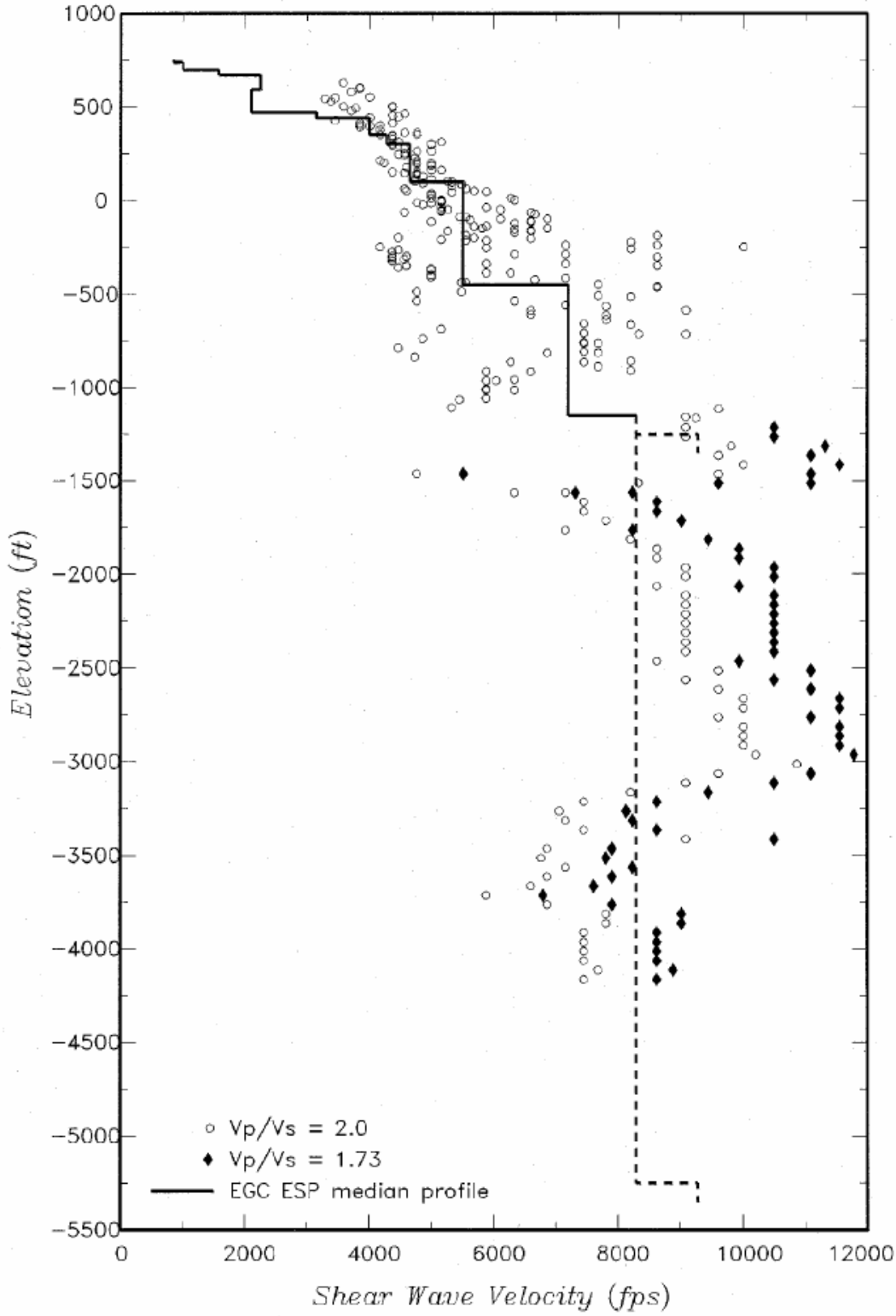


Seismic Hazards Report for the EGC ESP Site

Shear Modulus Reduction and Damping Relationships Developed by EPRI (1993)

Figure **4.2-7**

Non-GDS

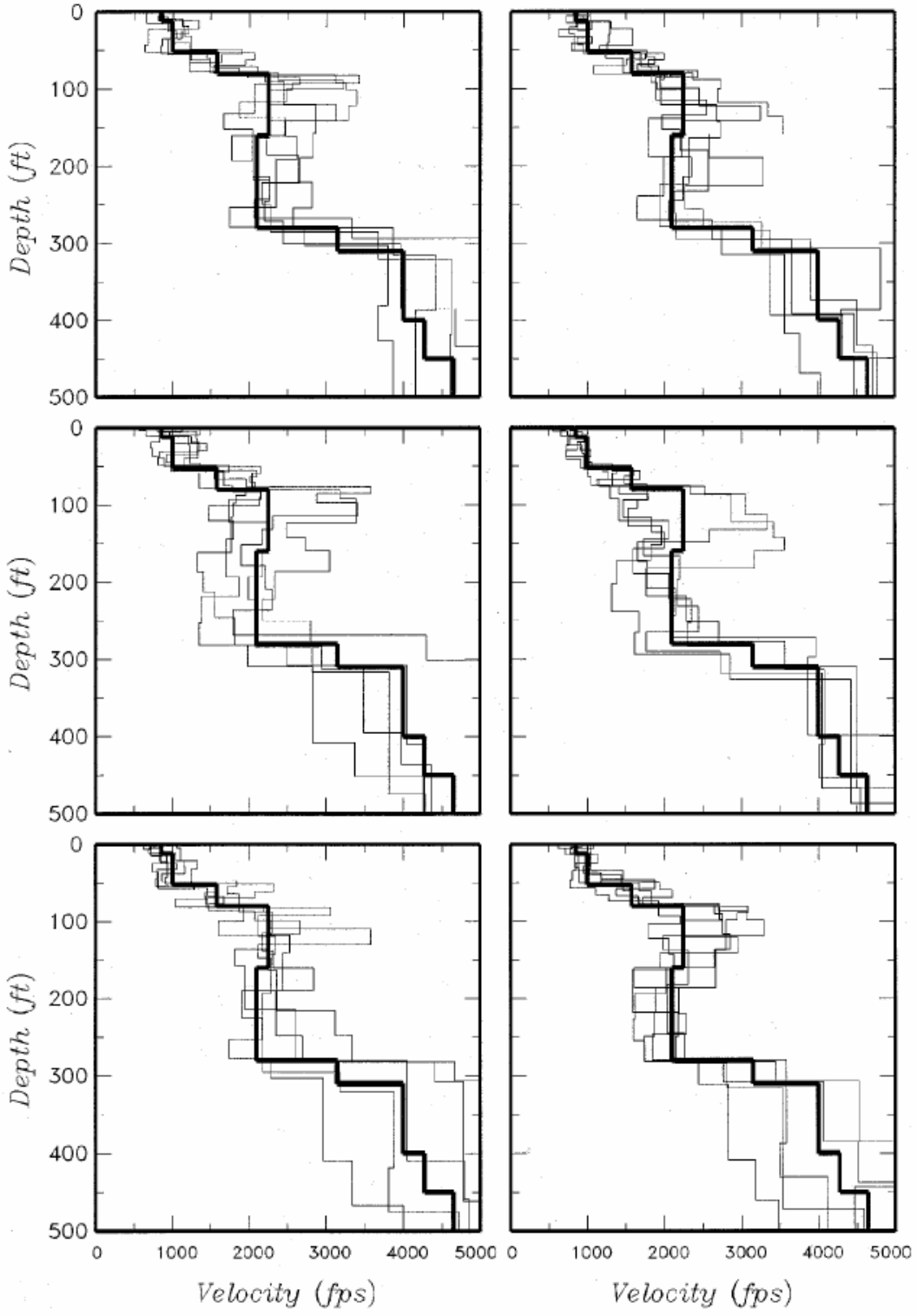


Seismic Hazards Report for the EGC ESP Site

Shear Wave Velocity Data for Sedimentary Rocks and Median Velocity Profile for the EGC ESP Site

Figure **4.2-8**

Non-GDS

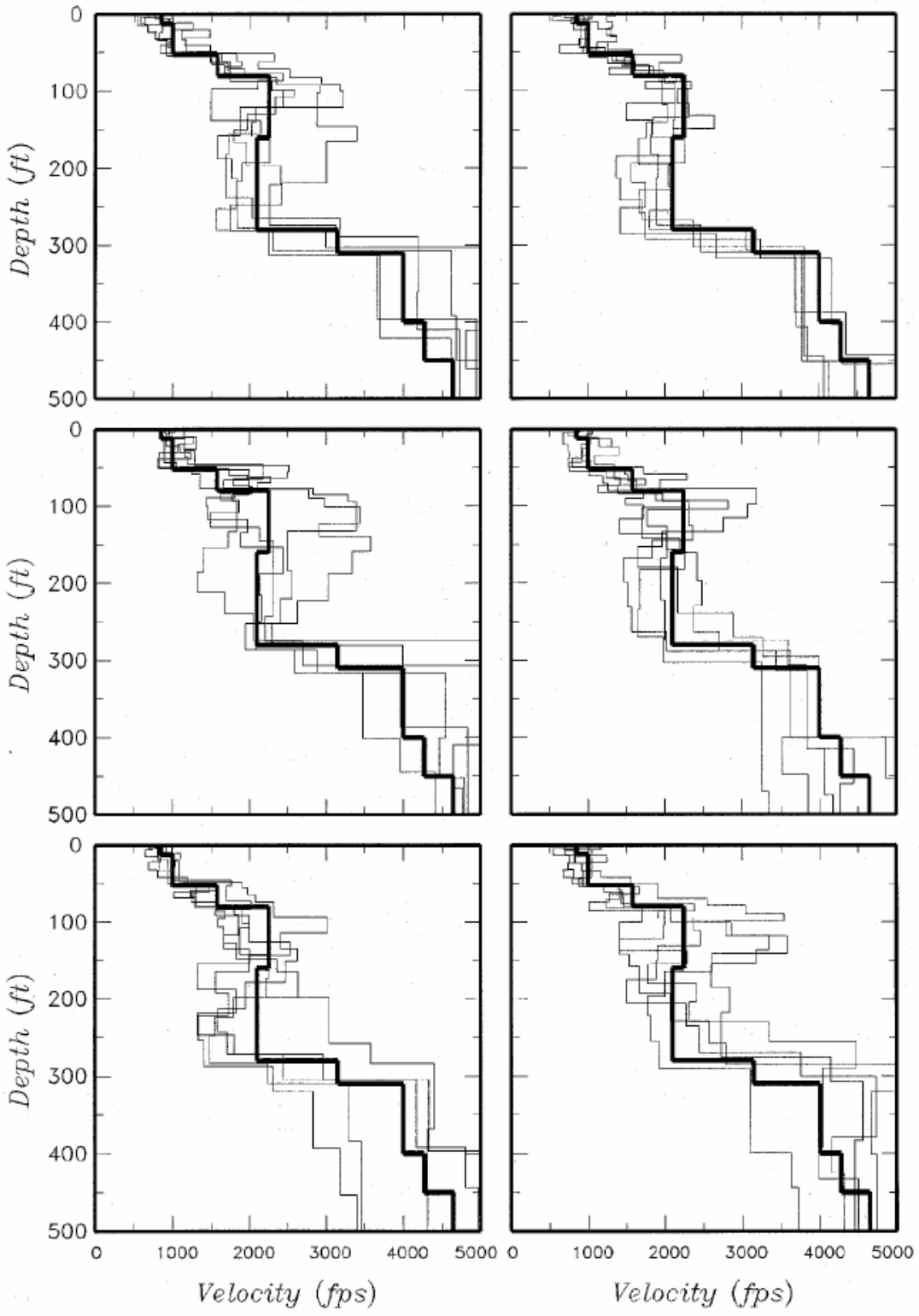


Seismic Hazards Report for the EGC ESP Site

Upper 500 Feet of First Thirty Randomized Shear Wave Velocity Profiles for the EGC ESP Site

Figure
4.2-9a

Non-GDS

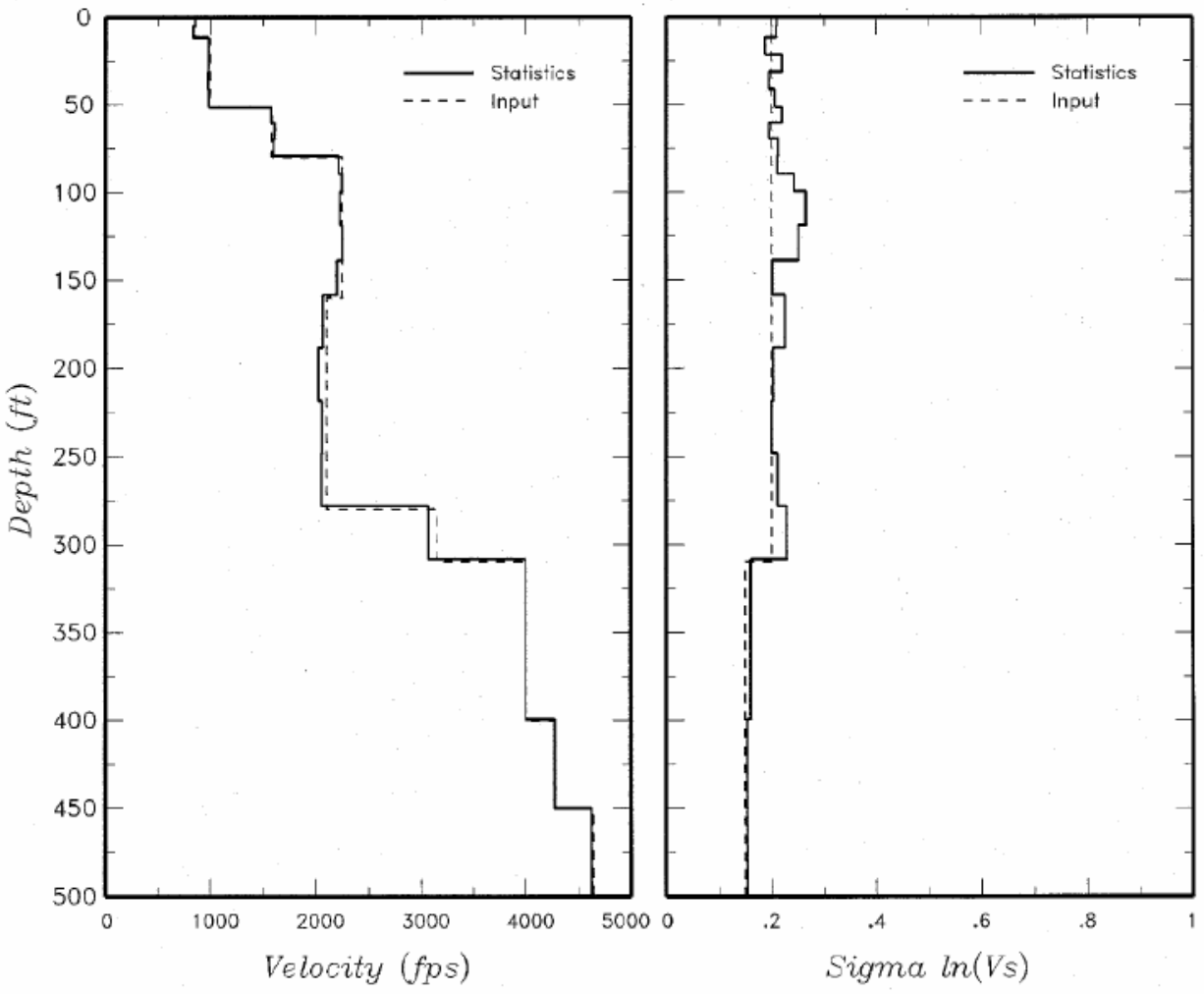


Seismic Hazards Report for the EGC ESP Site

Upper 500 Feet of Second Thirty Randomized Shear Wave Velocity Profiles for the EGC ESP Site

Figure
4.2-9b

Non-GDS

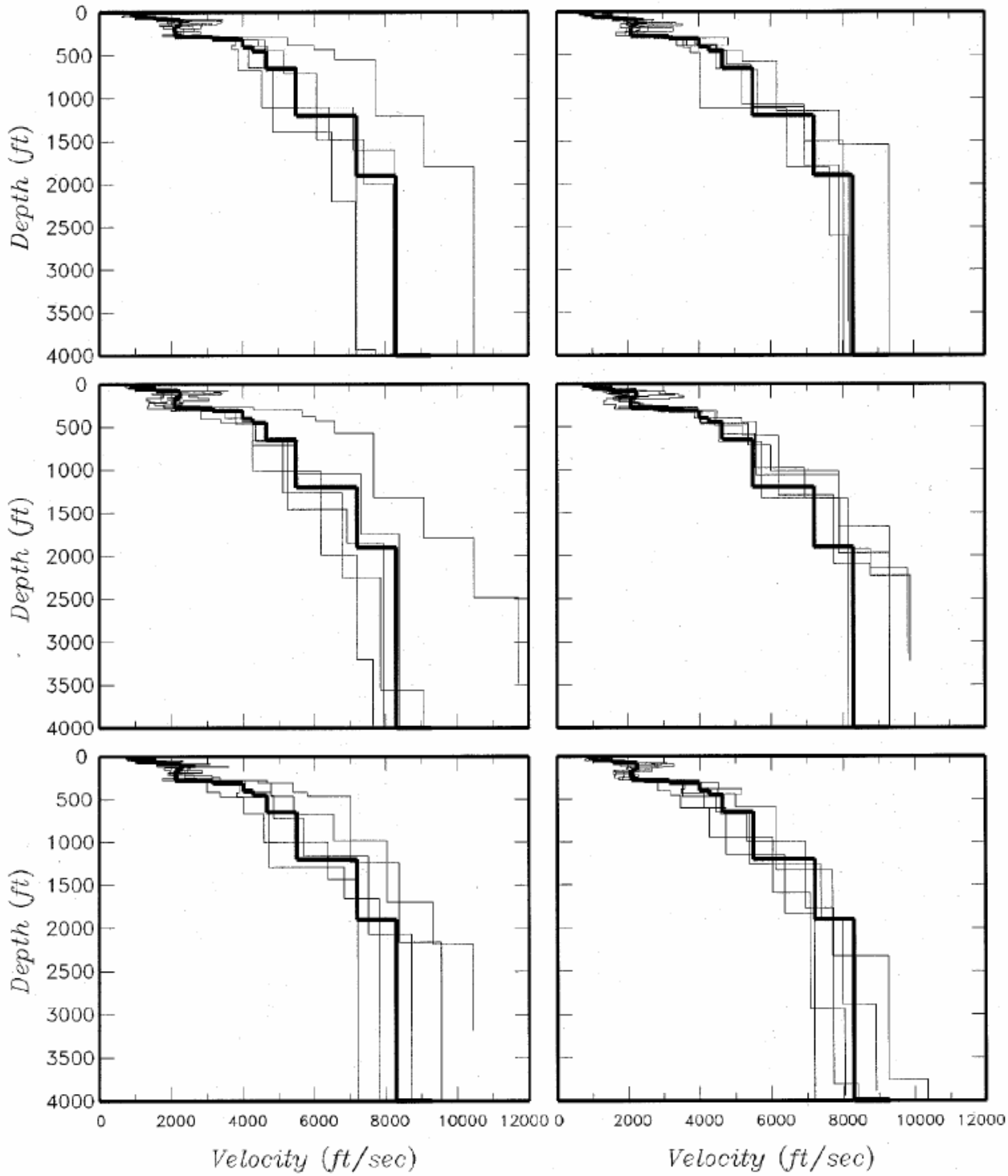


Seismic Hazards Report for the EGC ESP Site

Statistics of the Randomized Shear Wave Velocity Profiles (0 to 500-ft Depth)

Figure **4.2-10**

Non-GDS

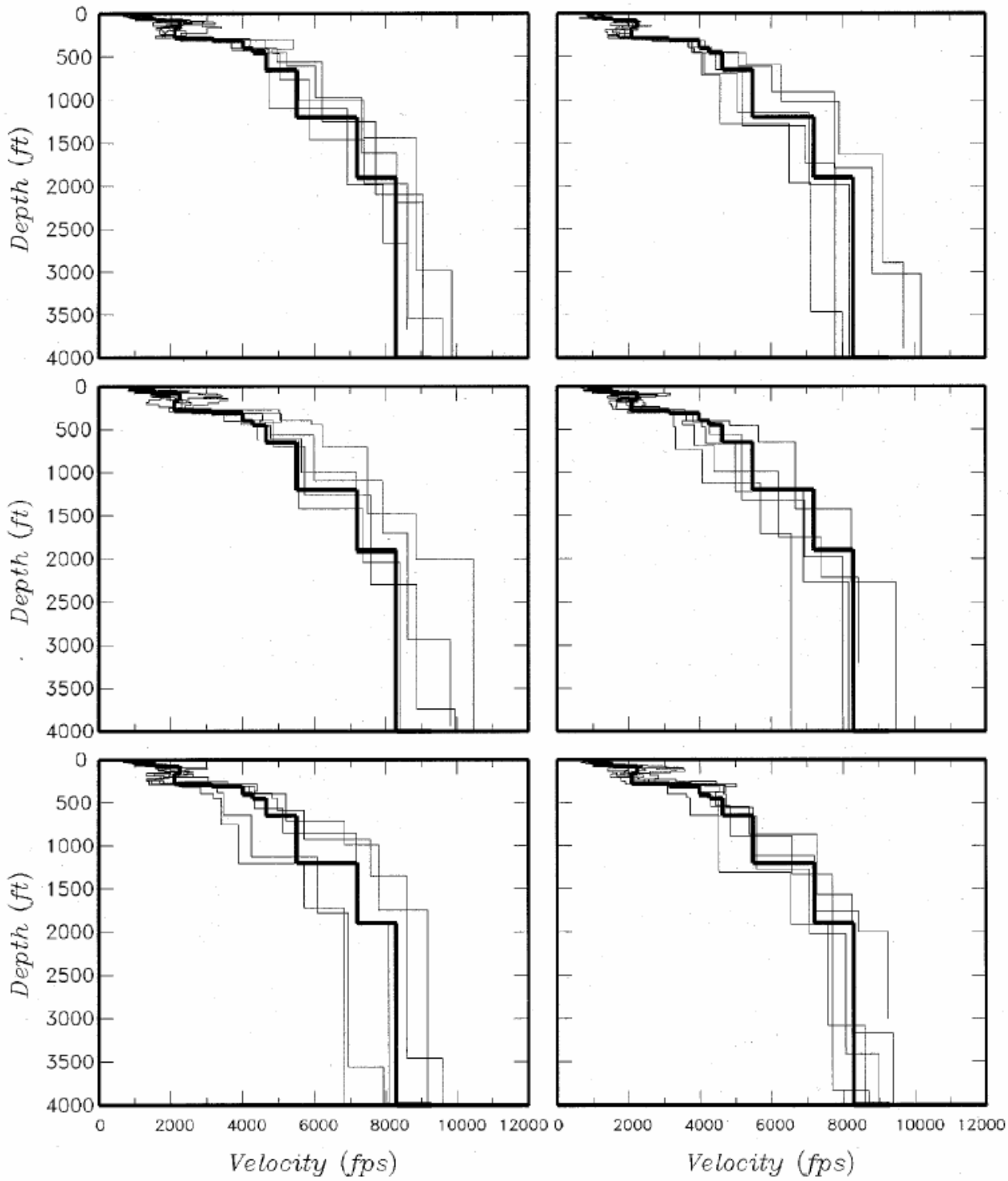


Seismic Hazards Report for the EGC ESP Site

First Thirty Randomized Shear Wave Velocity Profiles for the EGC ESP Site

Figure
4.2-11a

Non-GDS

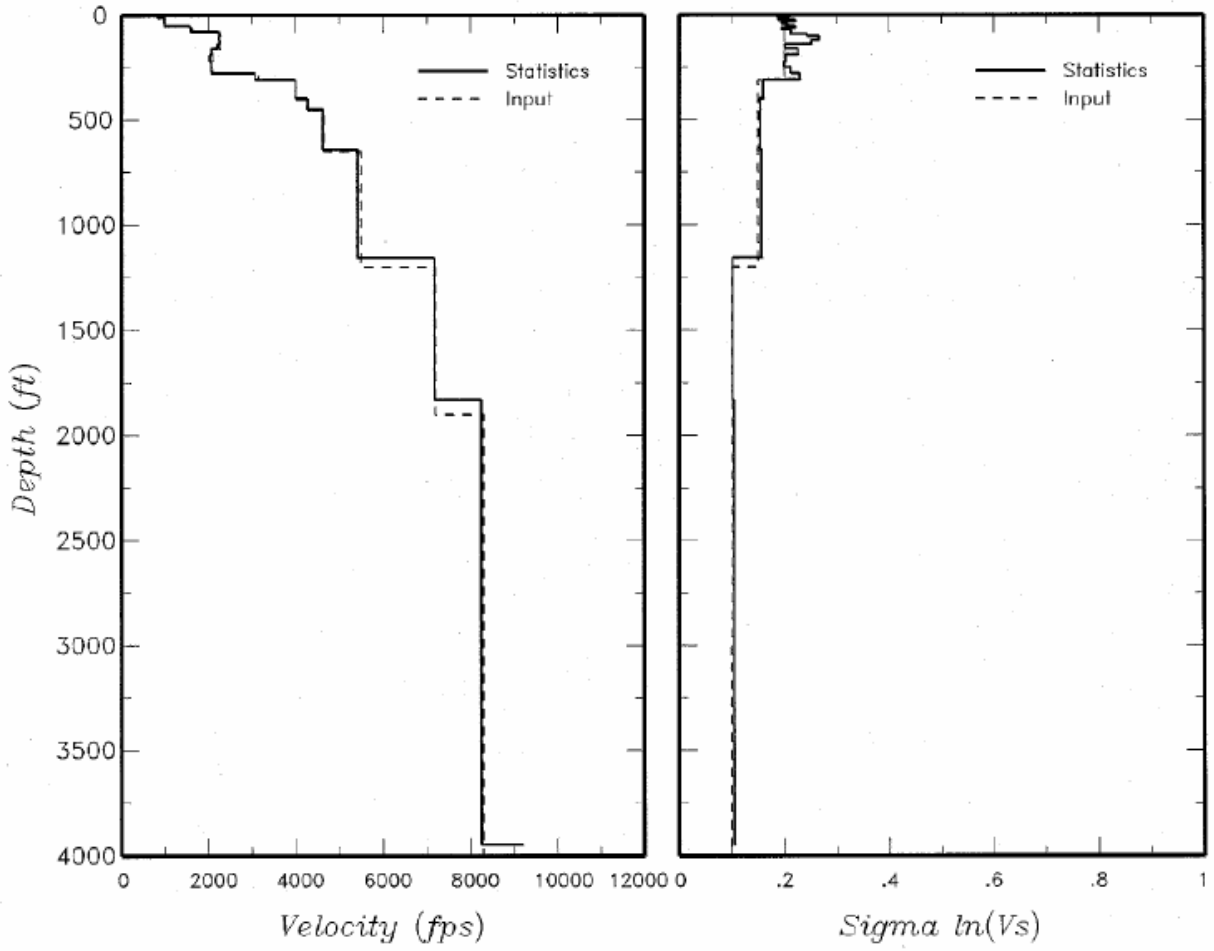


Seismic Hazards Report for the EGC ESP Site

Second Thirty Randomized Shear Wave Velocity Profiles for the EGC ESP Site

Figure **4.2-11b**

Non-GDS

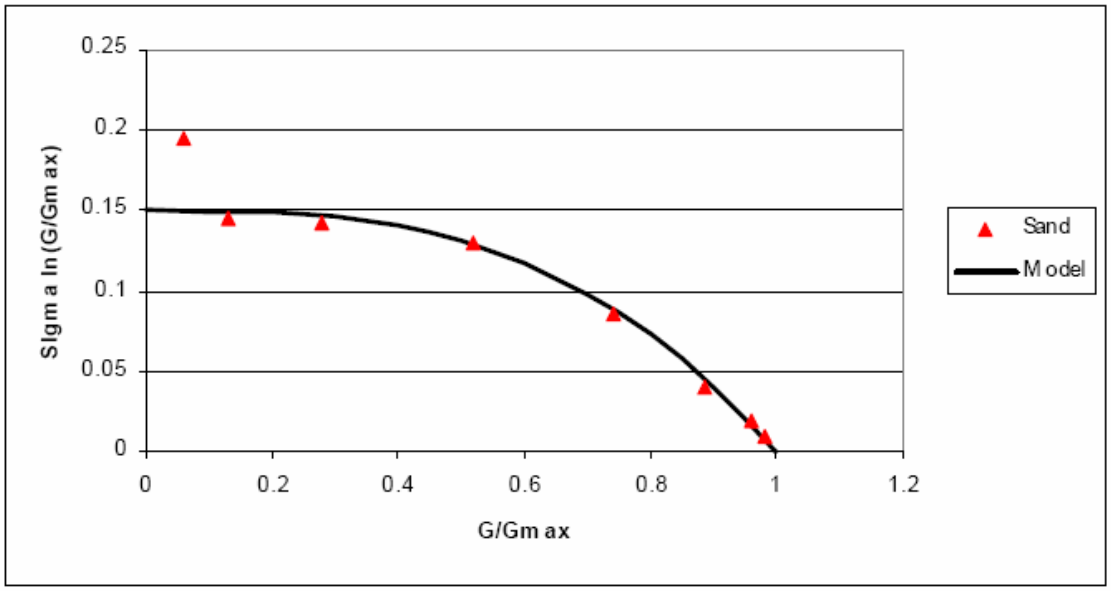


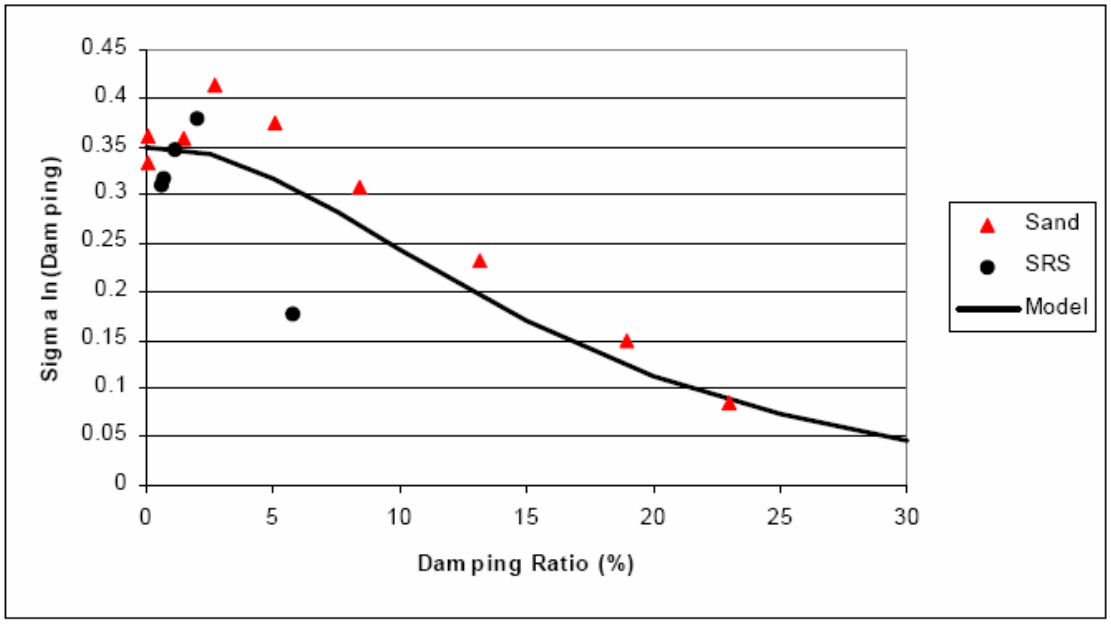
Seismic Hazards Report for the EGC ESP Site

Statistics of the Randomized Shear Wave Velocity Profiles (0 to 4,000-ft Depth)

Figure **4.2-12**

Non-GDS



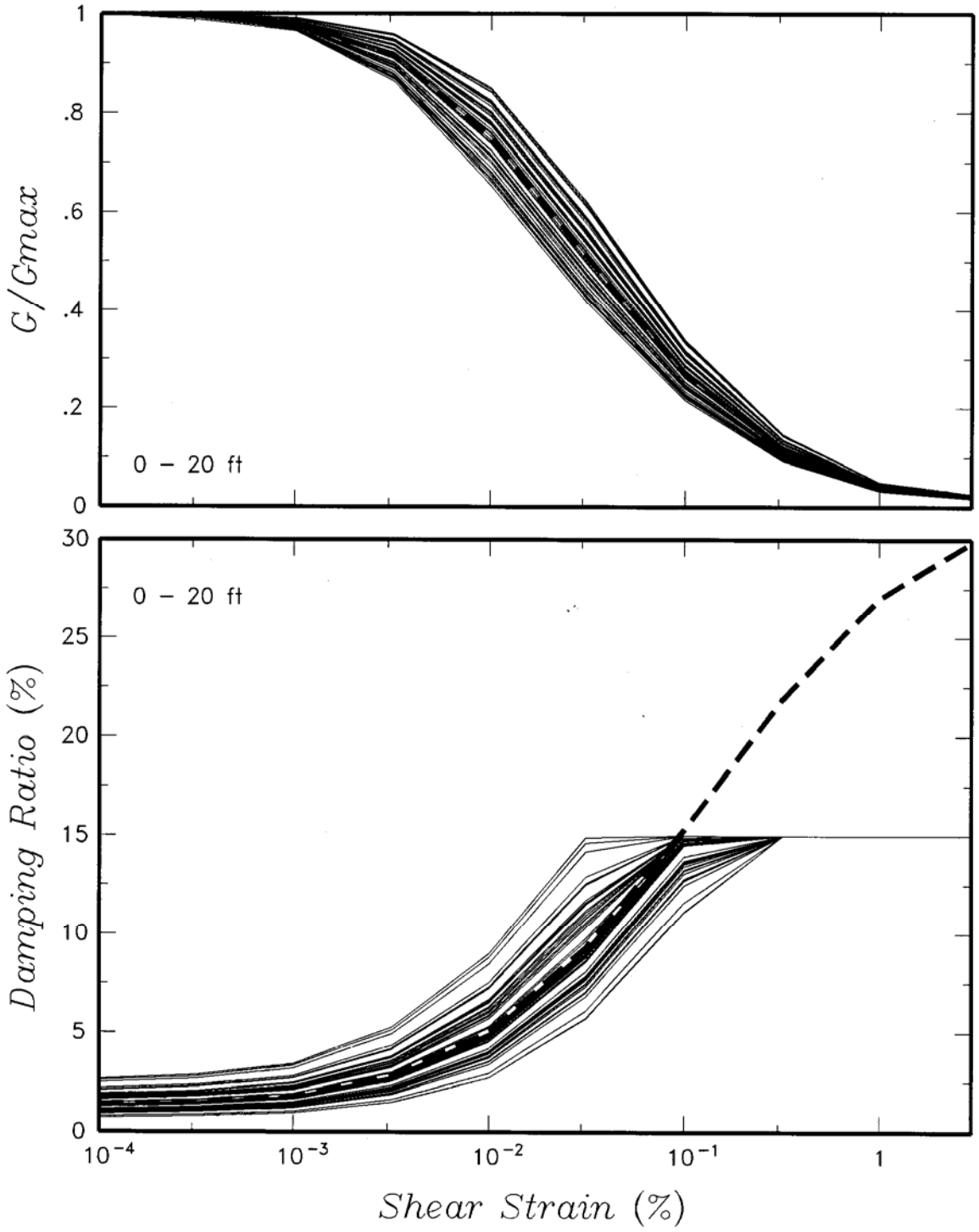


Seismic Hazards Report for the EGC ESP Site

Models for Variability in G/G_{max} and Damping Ratio

Figure
4.2-13

Non-GDS

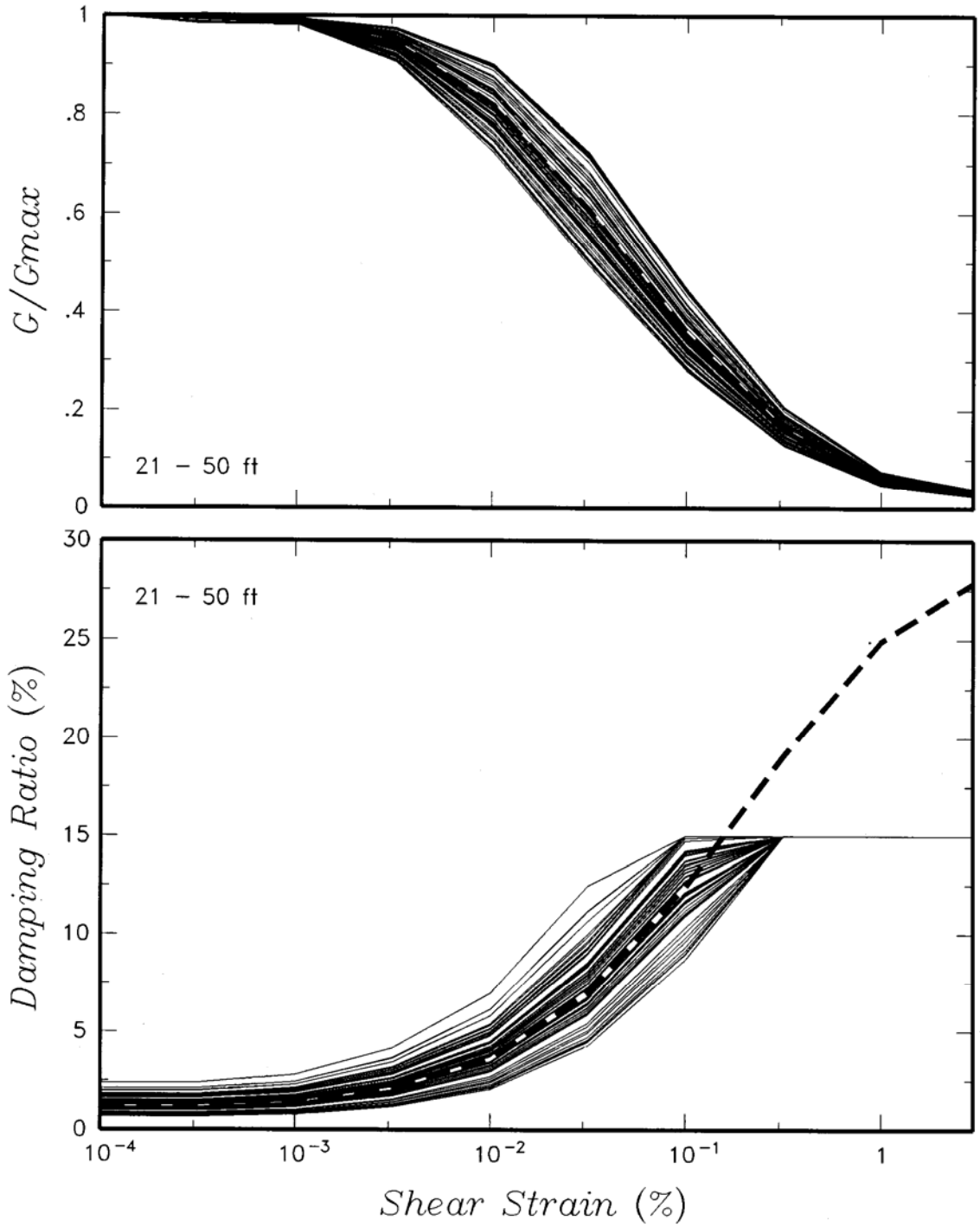


Seismic Hazards Report for the EGC ESP Site

Randomized Modulus Reduction and Damping Relationships for the Depth Range of 0 to 20 ft

Figure **4.2-14**

Non-GDS

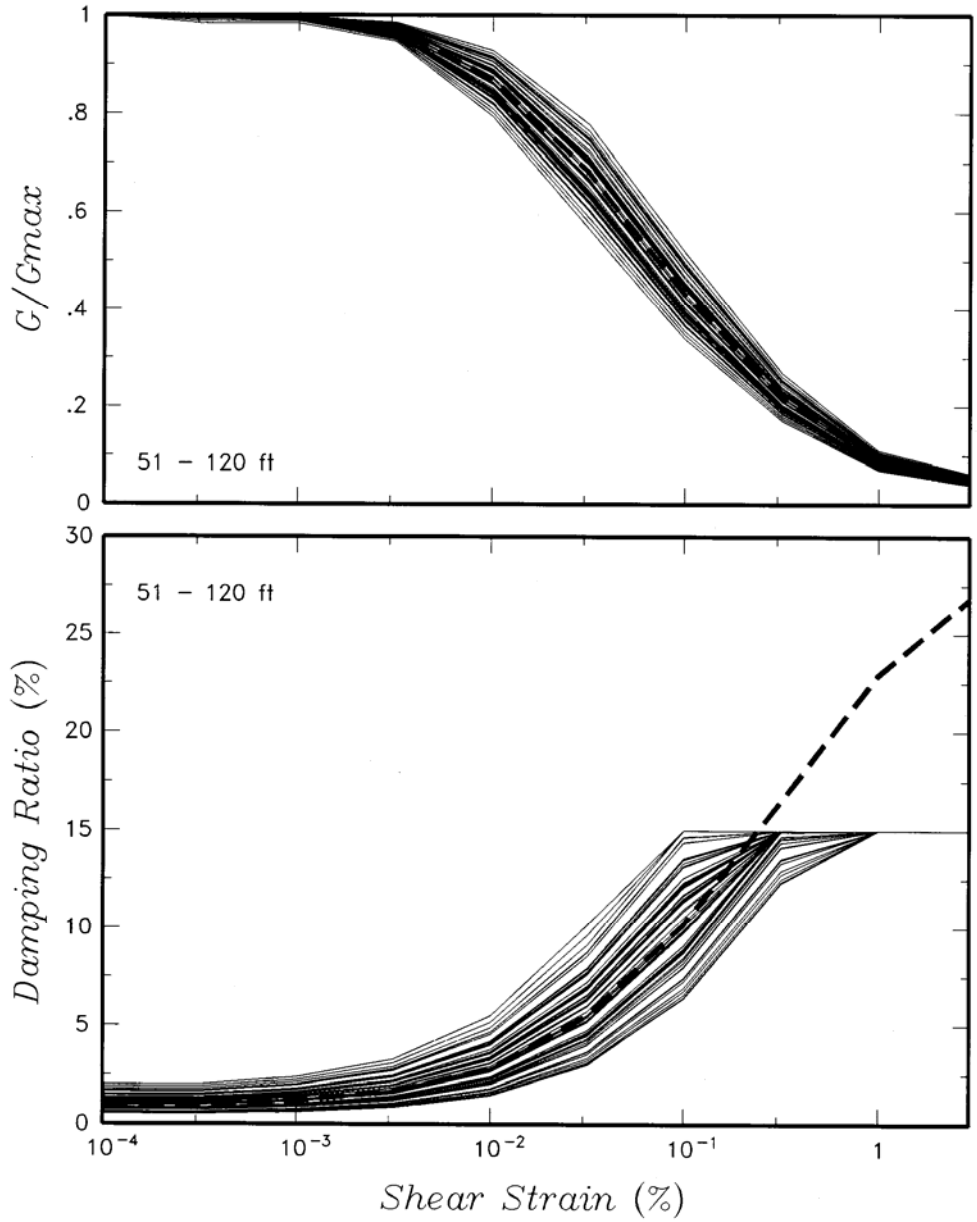


Seismic Hazards Report for the EGC ESP Site

Randomized Modulus Reduction and Damping Relationships for the Depth Range of 21 to 50 ft

Figure **4.2-15**

Non-GDS

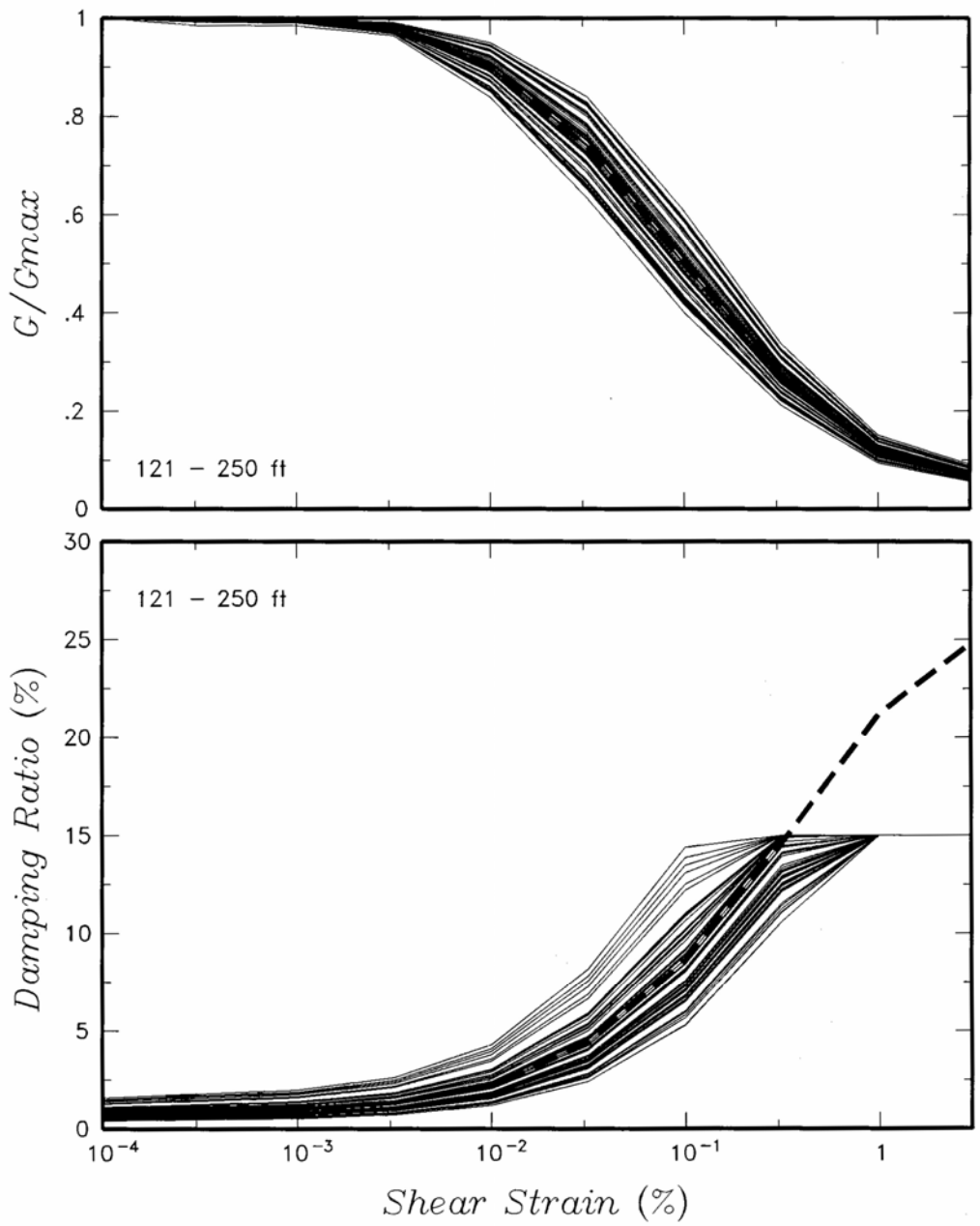


Seismic Hazards Report for the EGC ESP Site

Randomized Modulus Reduction and Damping Relationships for the Depth Range of 51 to 120 ft

Figure **4.2-16**

Non-GDS

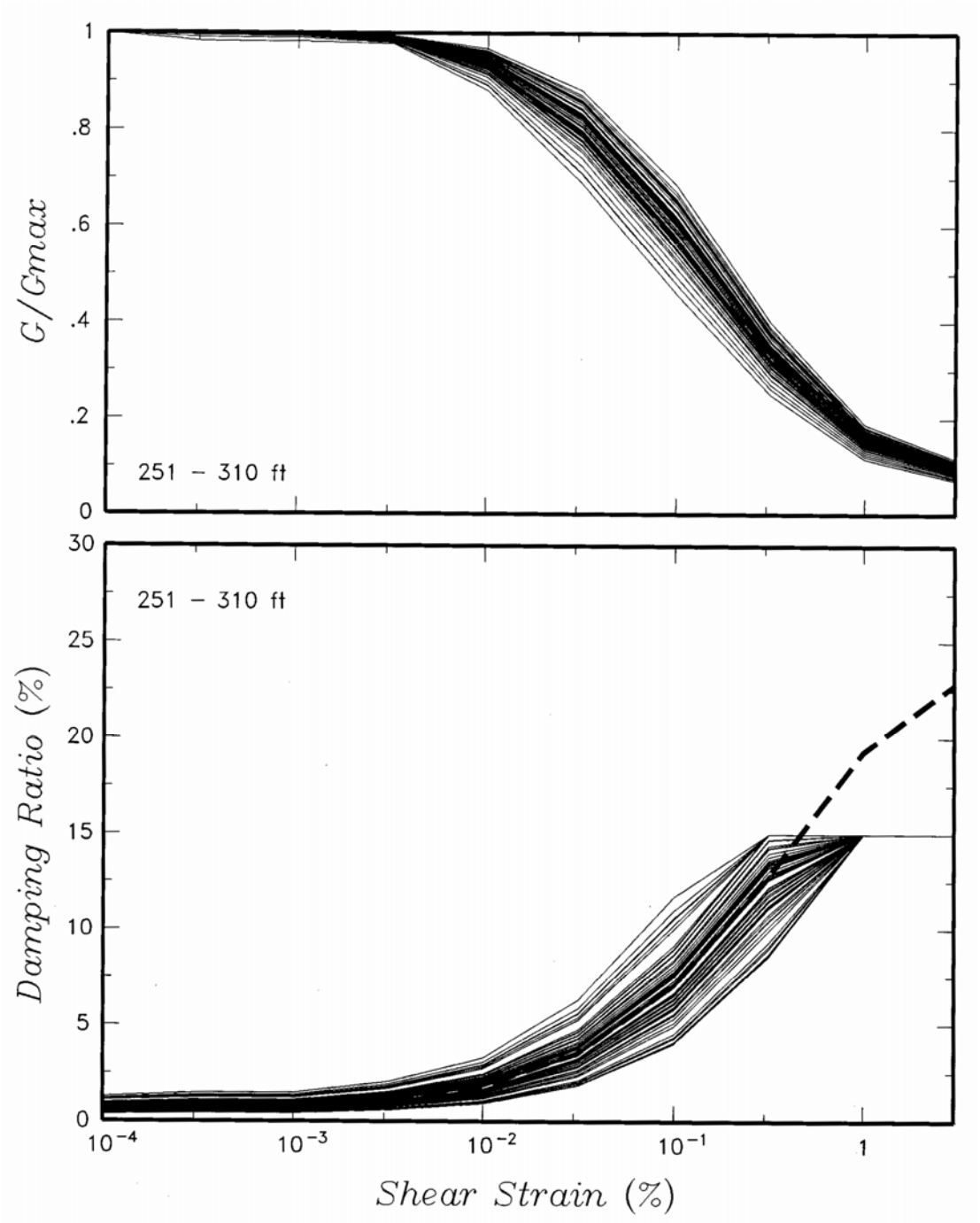


Seismic Hazards Report for the EGC ESP Site

Randomized Modulus Reduction and Damping Relationships for the Depth Range of 121 to 250 ft

Figure **4.2-17**

Non-GDS

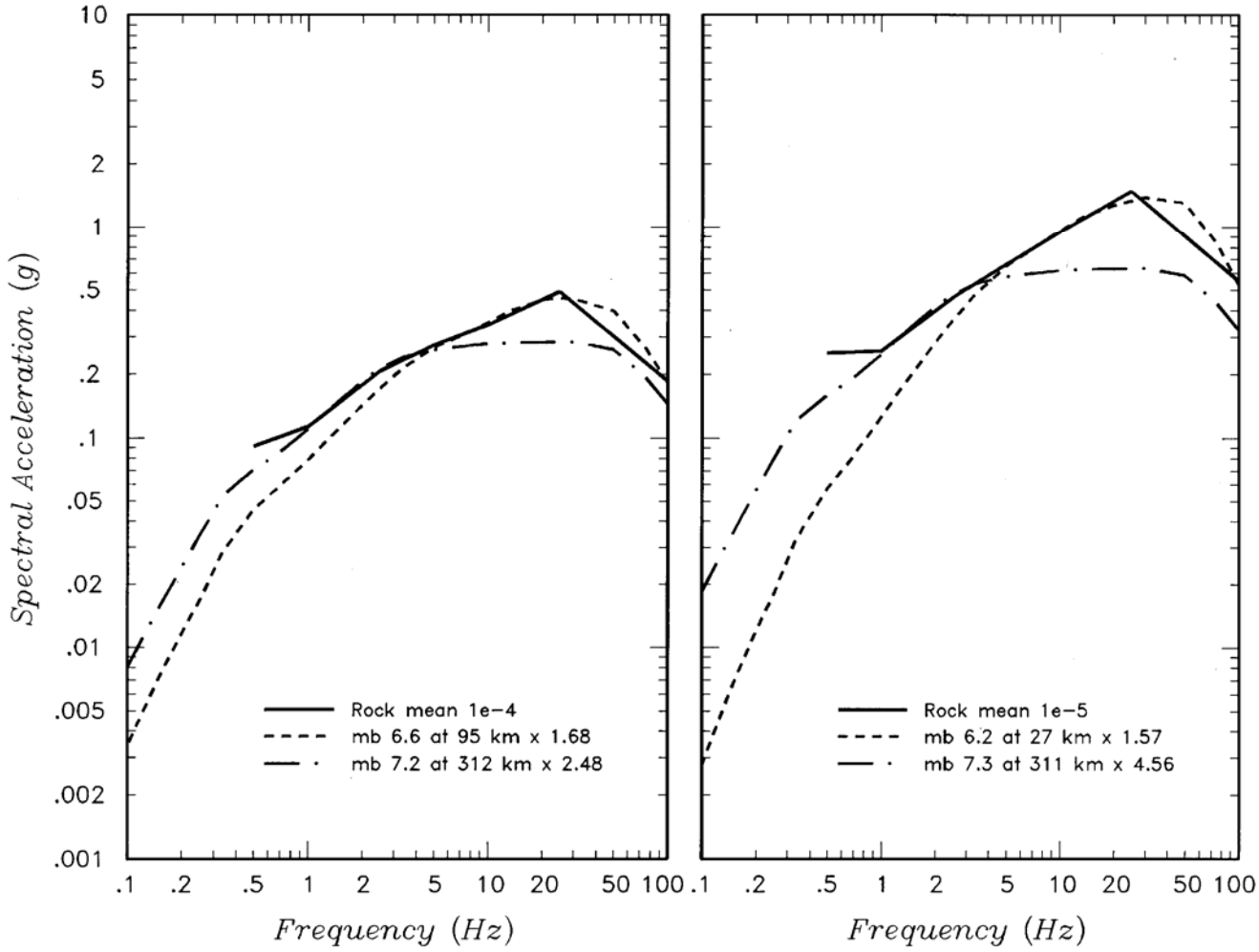


Seismic Hazards Report for the EGC ESP Site

Randomized Modulus Reduction and Damping Relationships for the Depth Range of 251 to 310 ft

Figure **4.2-18**

Non-GDS

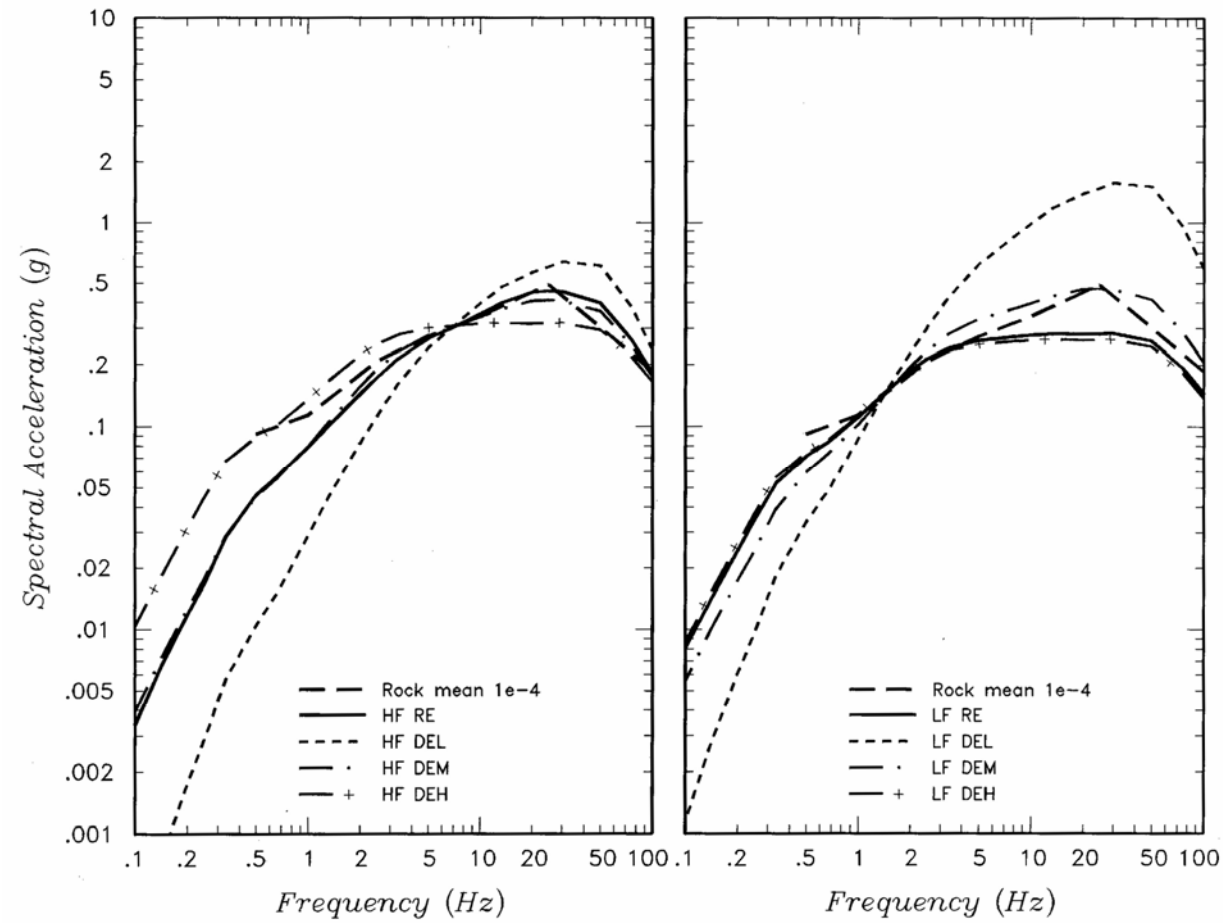


Seismic Hazards Report for the EGC ESP Site

Reference Earthquake (RE) Response Spectra for Mean 10^{-4} and Mean 10^{-5} Hazard

Figure **4.2-19**

Non-GDS

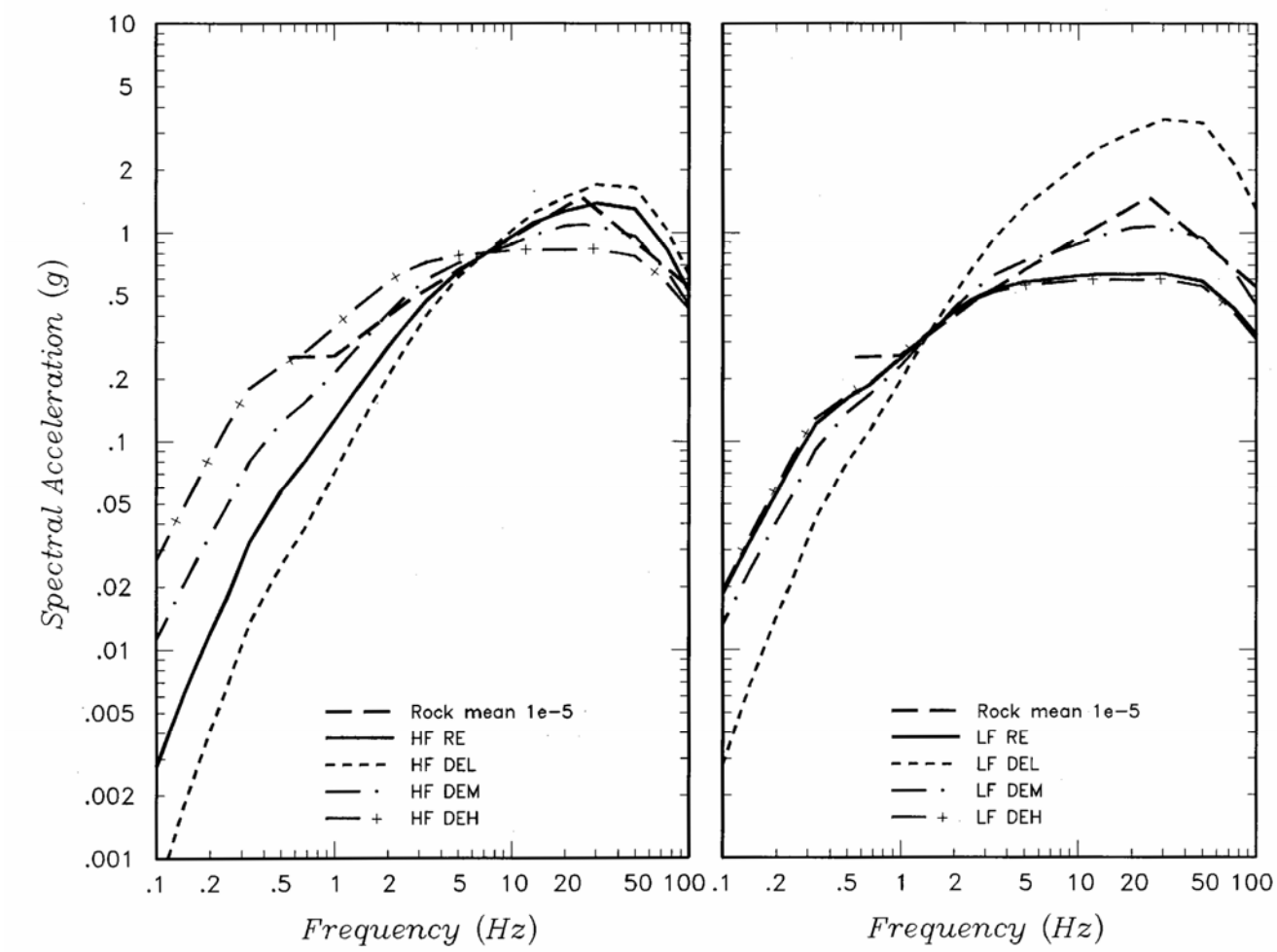


Seismic Hazards Report for the EGC ESP Site

Reference Earthquake (RE) and Deaggregation Earthquake (DE) Response Spectra for Mean 10^{-4} Hazard

Figure **4.2-20**

Non-GDS

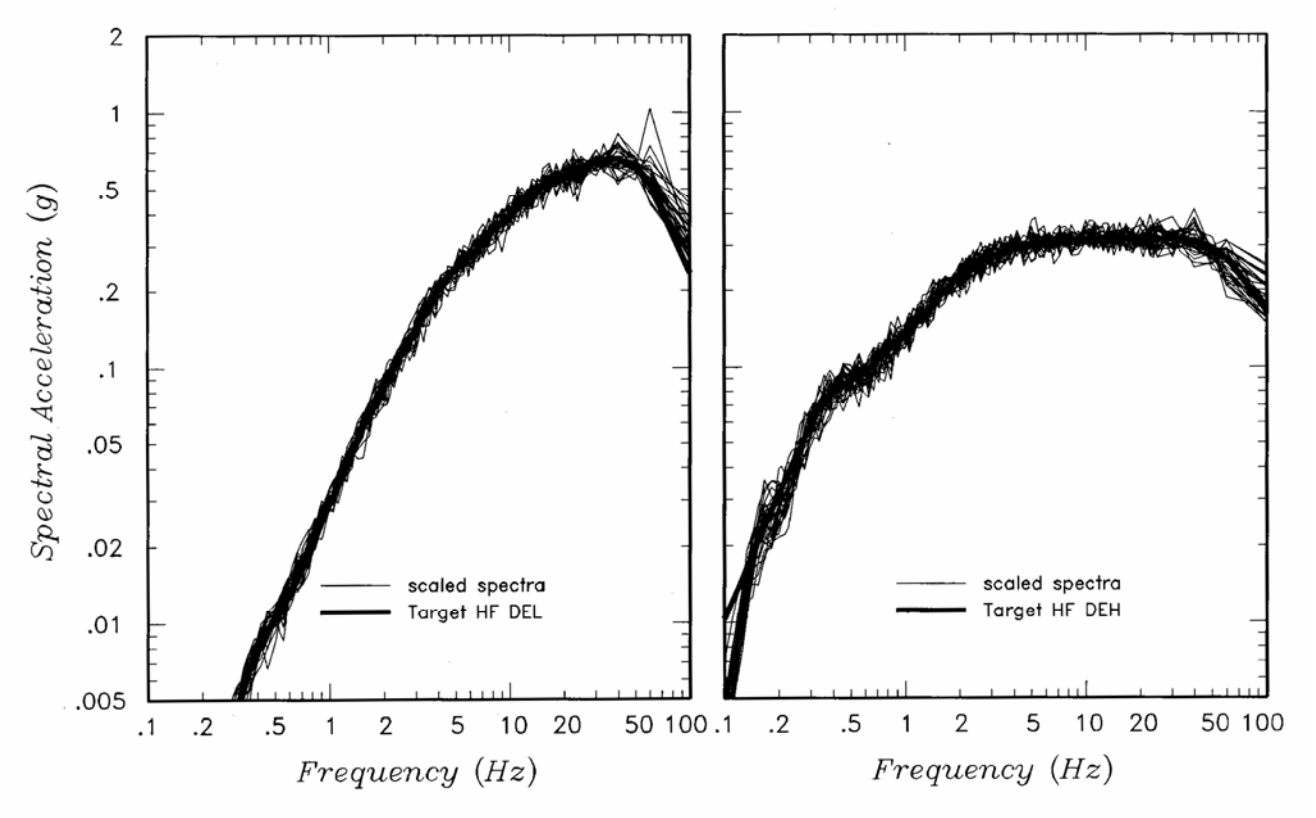


Seismic Hazards Report for the EGC ESP Site

Reference Earthquake (RE) and Deaggregation Earthquake (DE) Response Spectra for Mean 10^{-5} Hazard

Figure **4.2-21**

Non-GDS

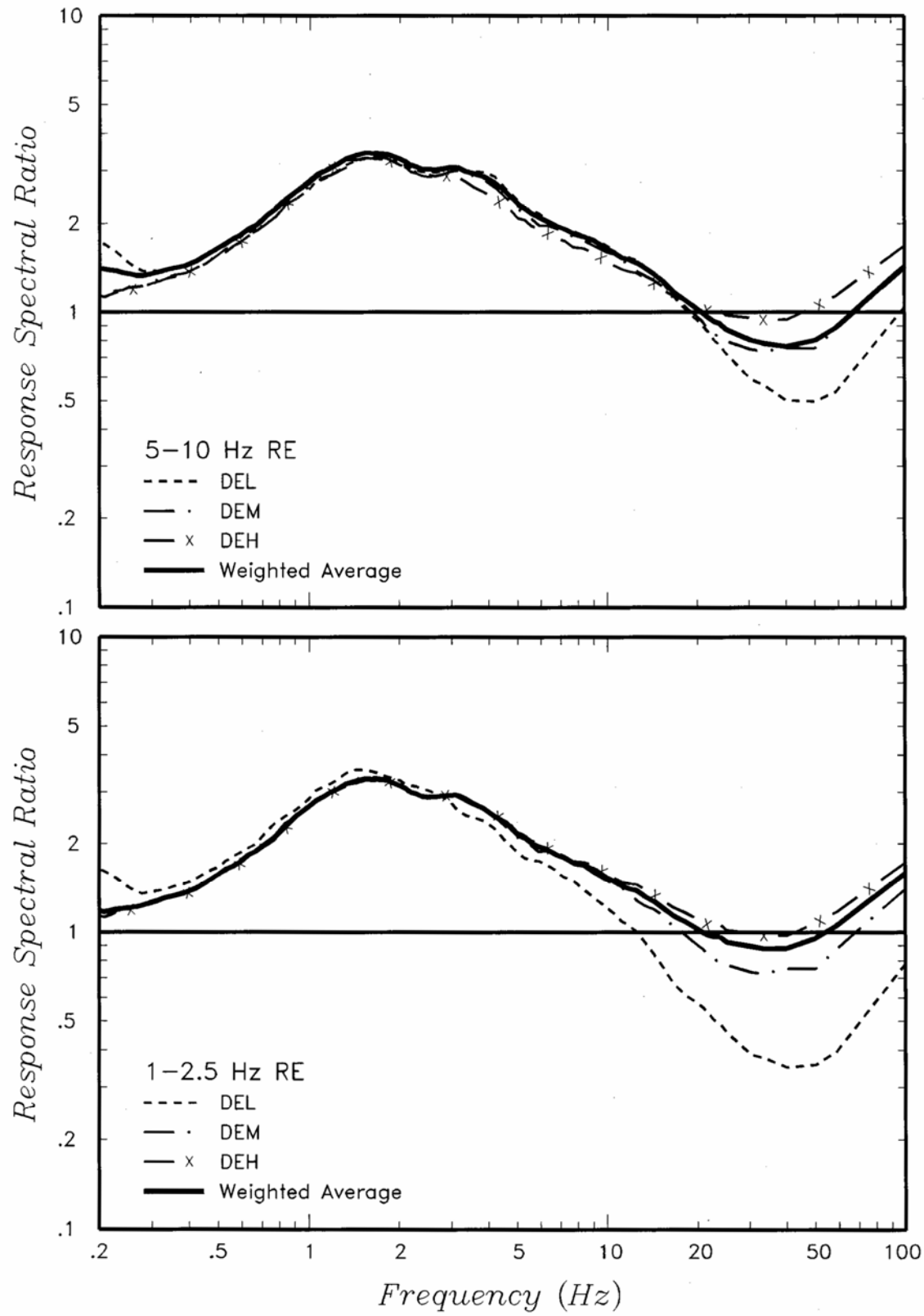


Seismic Hazards Report for the EGC ESP Site

Example of 30 Response Spectra Scaled to Deaggregation Earthquake Spectrum

Figure **4.2-22**

Non-GDS

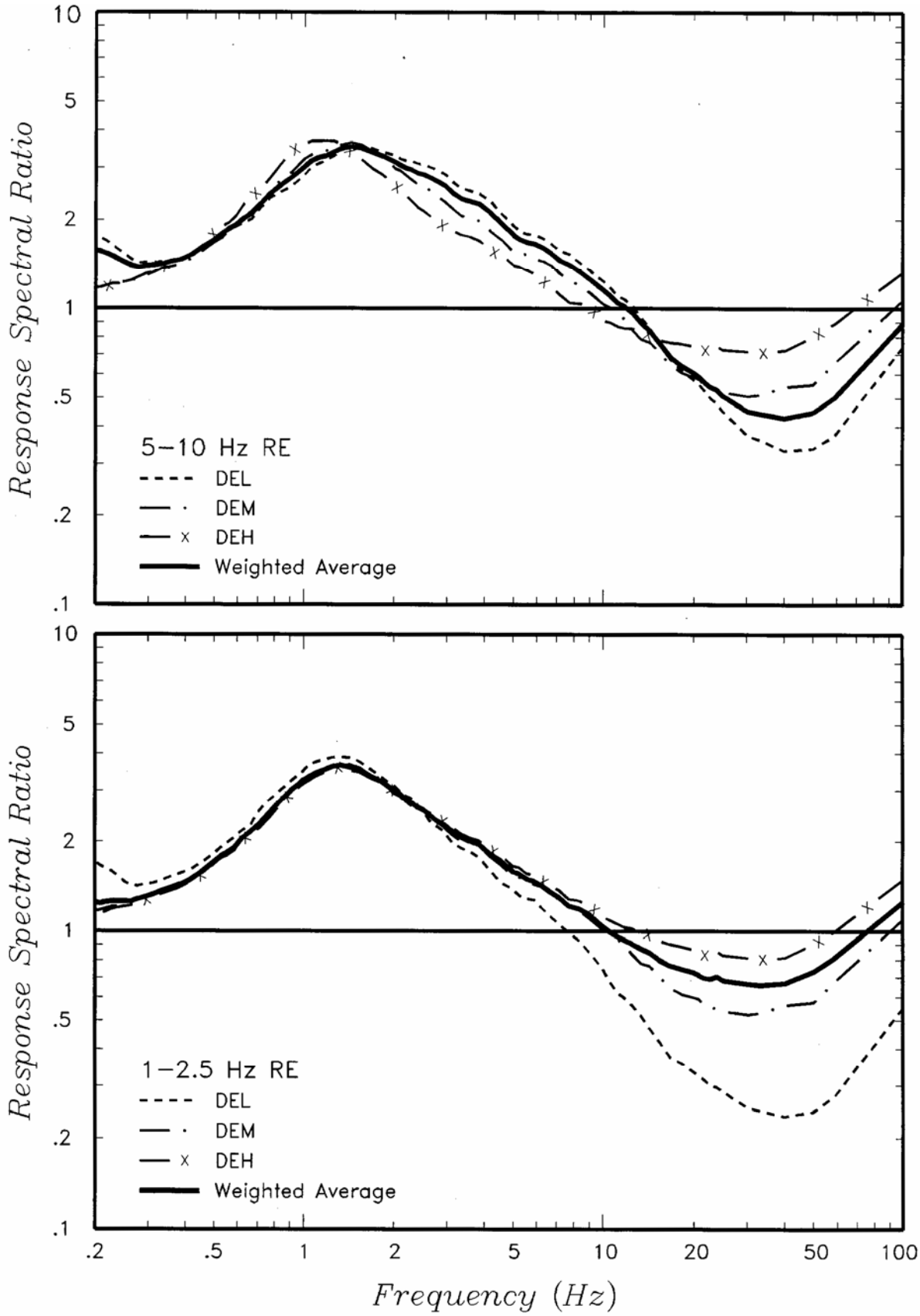


Seismic Hazards Report for the EGC ESP Site

Mean Site Amplification Functions for Deaggregation Earthquakes and Weighted Average Site Amplification Functions for Reference Earthquakes for Mean 10^{-4} Hazard

Figure
4.2-23

Non-GDS

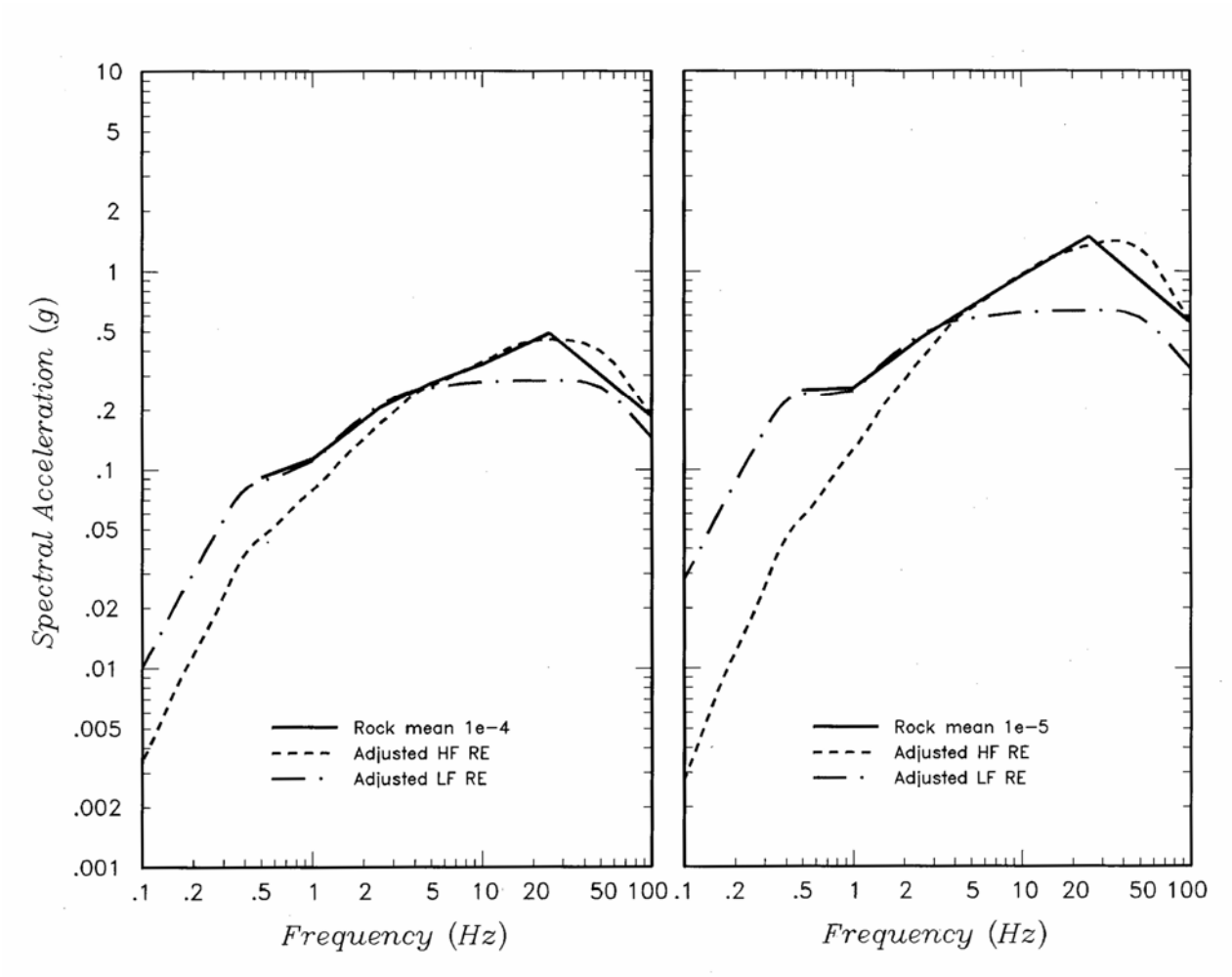


Seismic Hazards Report for the EGC ESP Site

Mean Site Amplification Functions for Deaggregation Earthquakes and Weighted Average Site Amplification Functions for Reference Earthquakes for Mean 10^{-5} Hazard

Figure **4.2-24**

Non-GDS

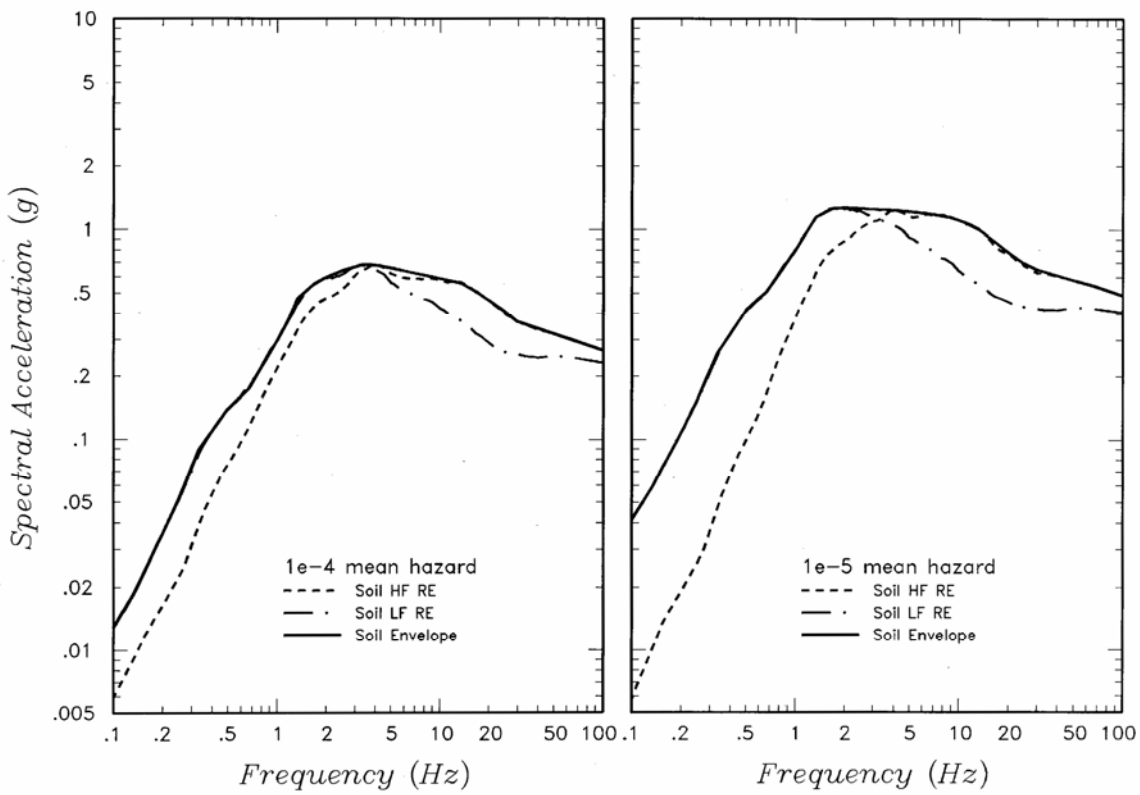


Seismic Hazards Report for the EGC ESP Site

Adjusted Rock Reference Earthquake Response Spectra

Figure
4.2-25

Non-GDS

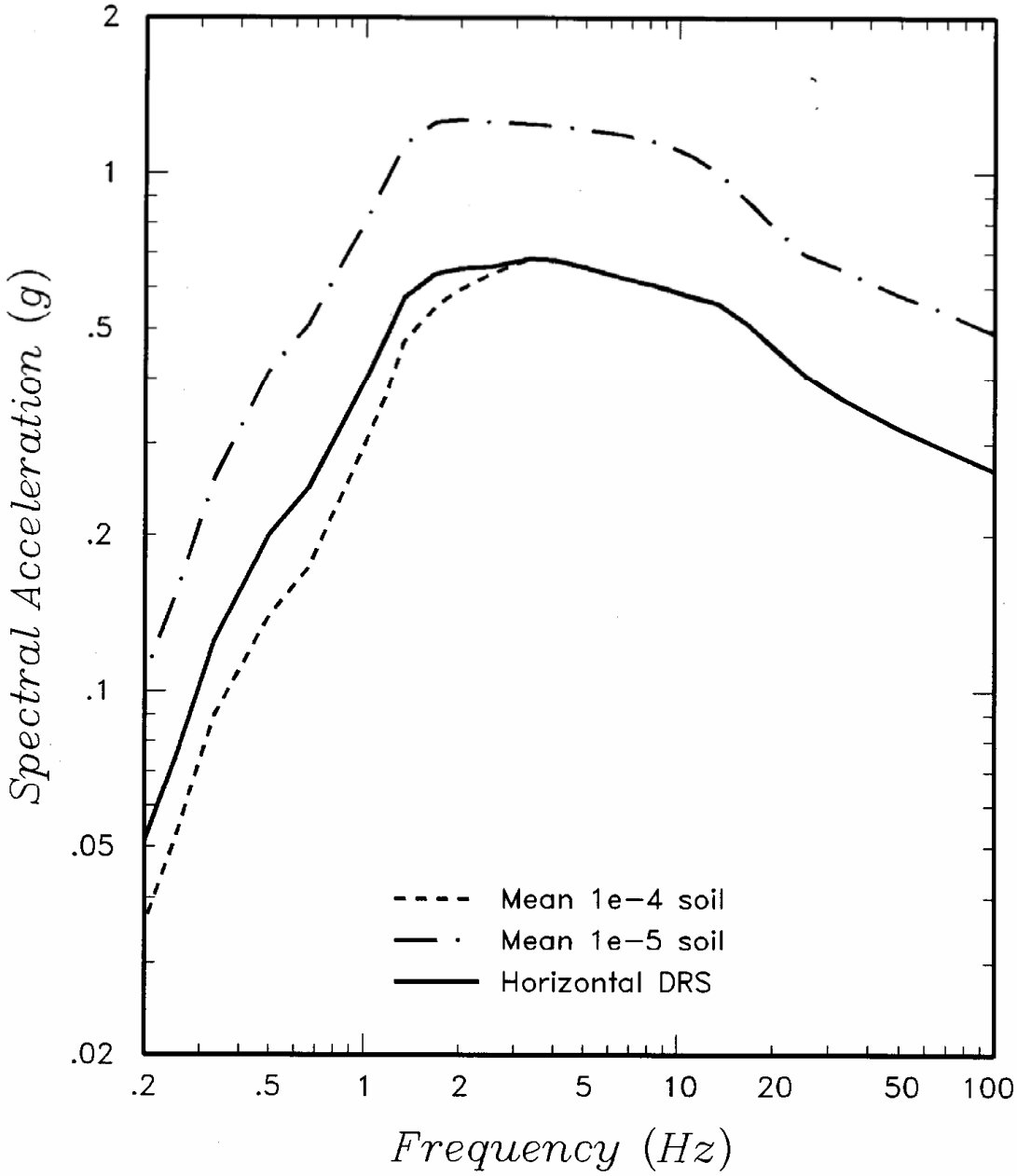


Seismic Hazards Report for the EGC ESP Site

Rock Reference Earthquake Spectra Scaled by Weighted Average Site Amplification Functions and Soil Envelope Spectra

Figure **4.2-26**

Non-GDS

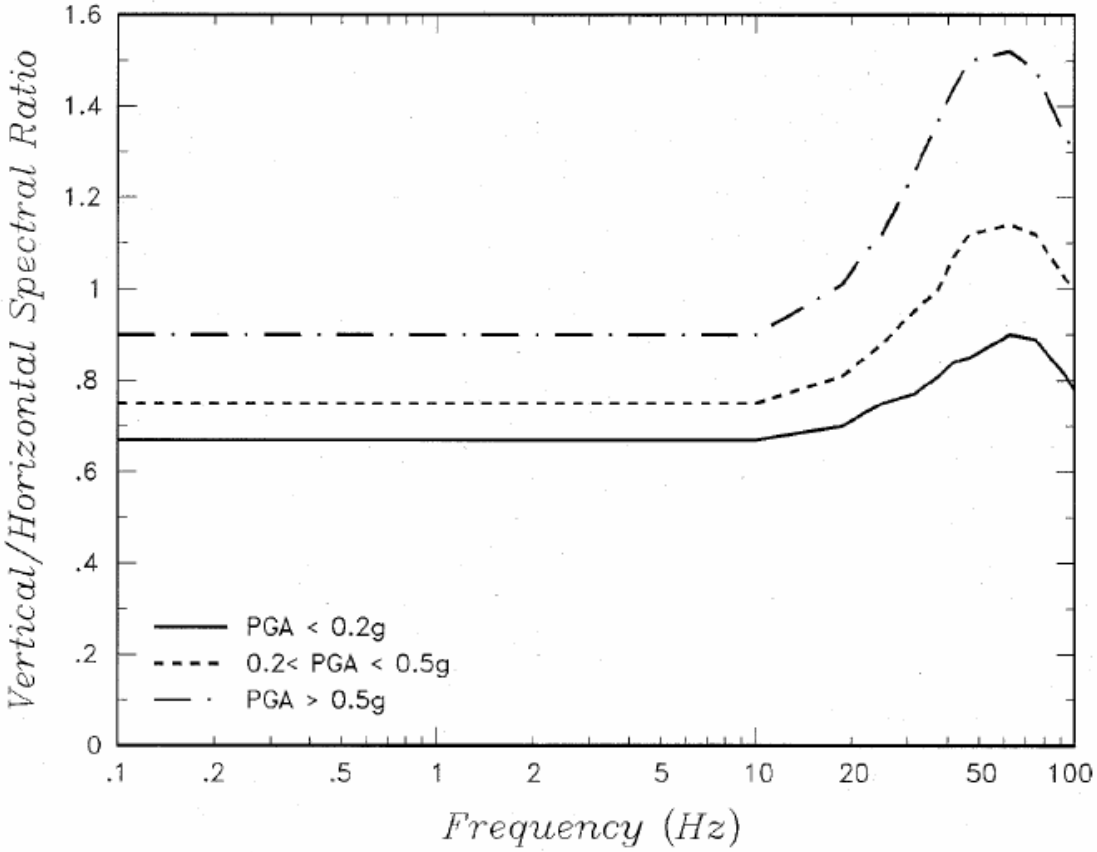


Seismic Hazards Report for the EGC ESP Site

Development of Horizontal DRS Spectrum

Figure
4.3-1

Non-GDS

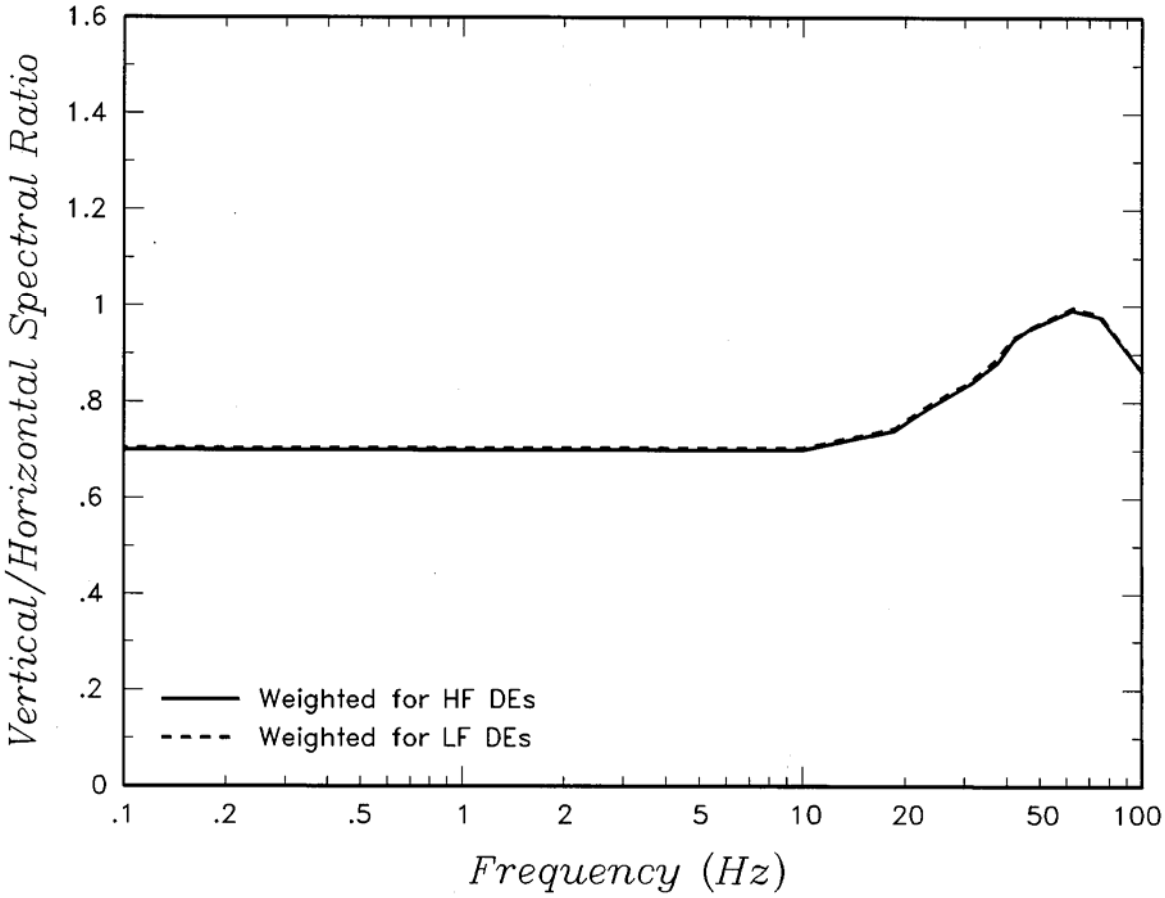


Seismic Hazards Report for the EGC ESP Site

Recommended Vertical/Horizontal Response Spectral Ratios for CEUS Rock Site Conditions Given in NUREG/CR-6728

Figure **4.3-2**

Non-GDS

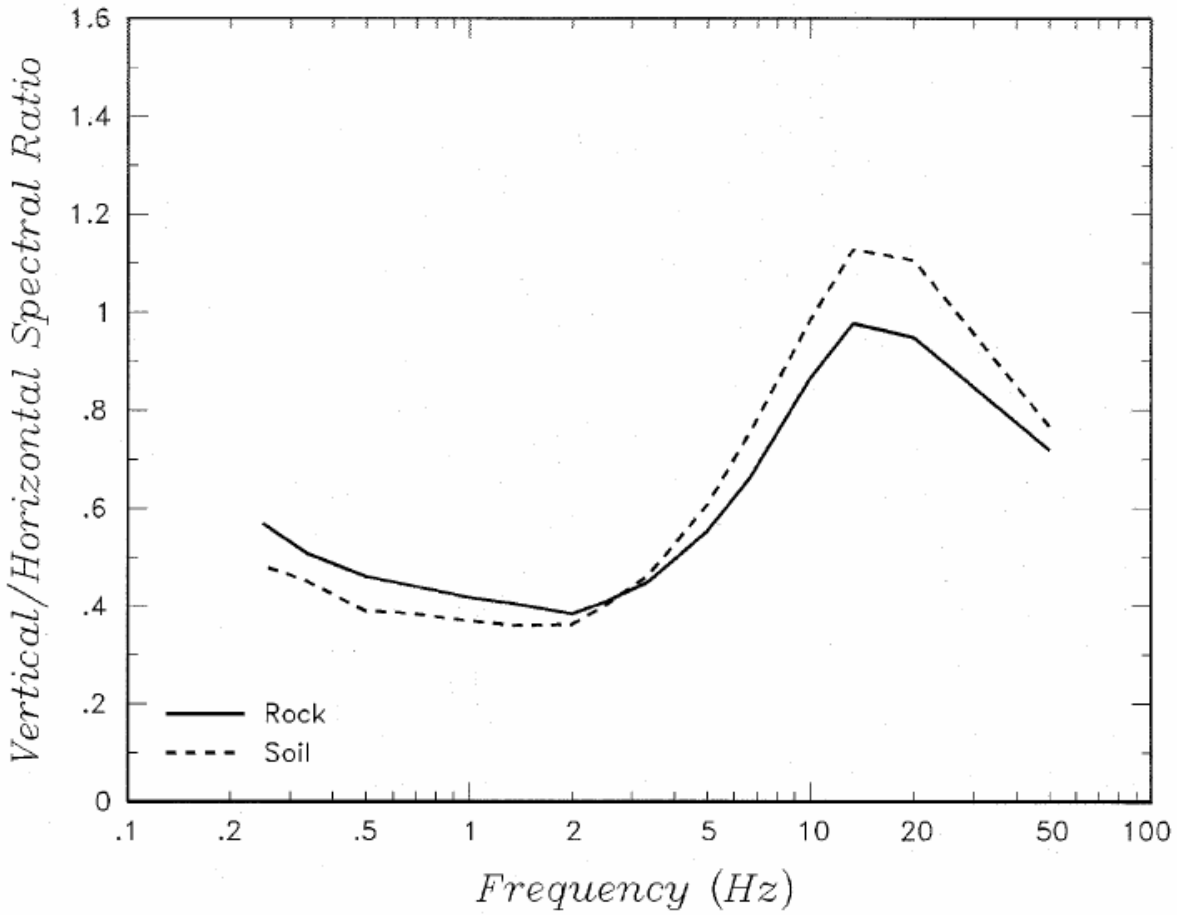


Seismic Hazards Report for the EGC ESP Site

Weighted Average Vertical/Horizontal Response Spectral Ratios for Rock Site Conditions for Mean 10^{-4} Hazard Level at EGC ESP Site

Figure **4.3-3**

Non-GDS

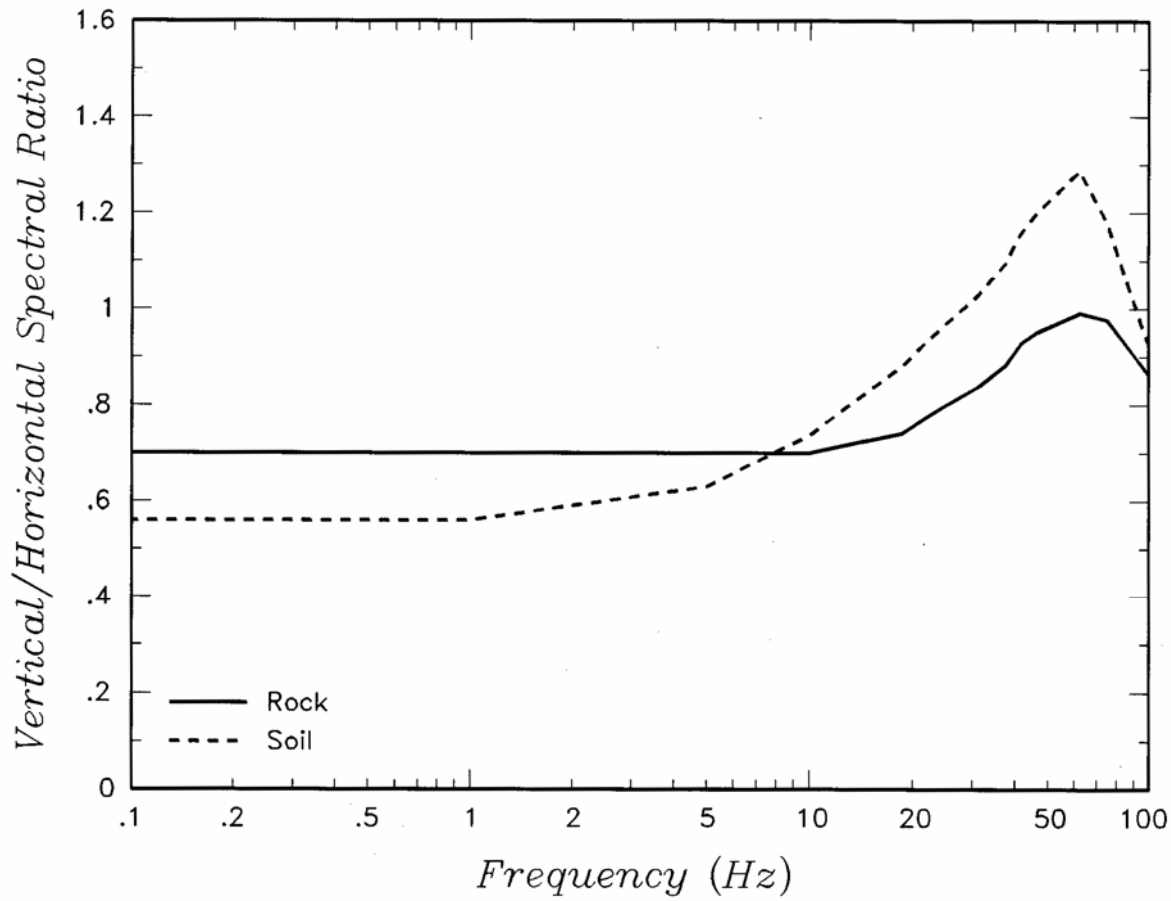


Seismic Hazards Report for the EGC ESP Site

Vertical/Horizontal Response Spectral Ratios for WUS Rock and Soil Rock Site Conditions Based on Empirical Ground Motion Models

Figure **4.3-4**

Non-GDS

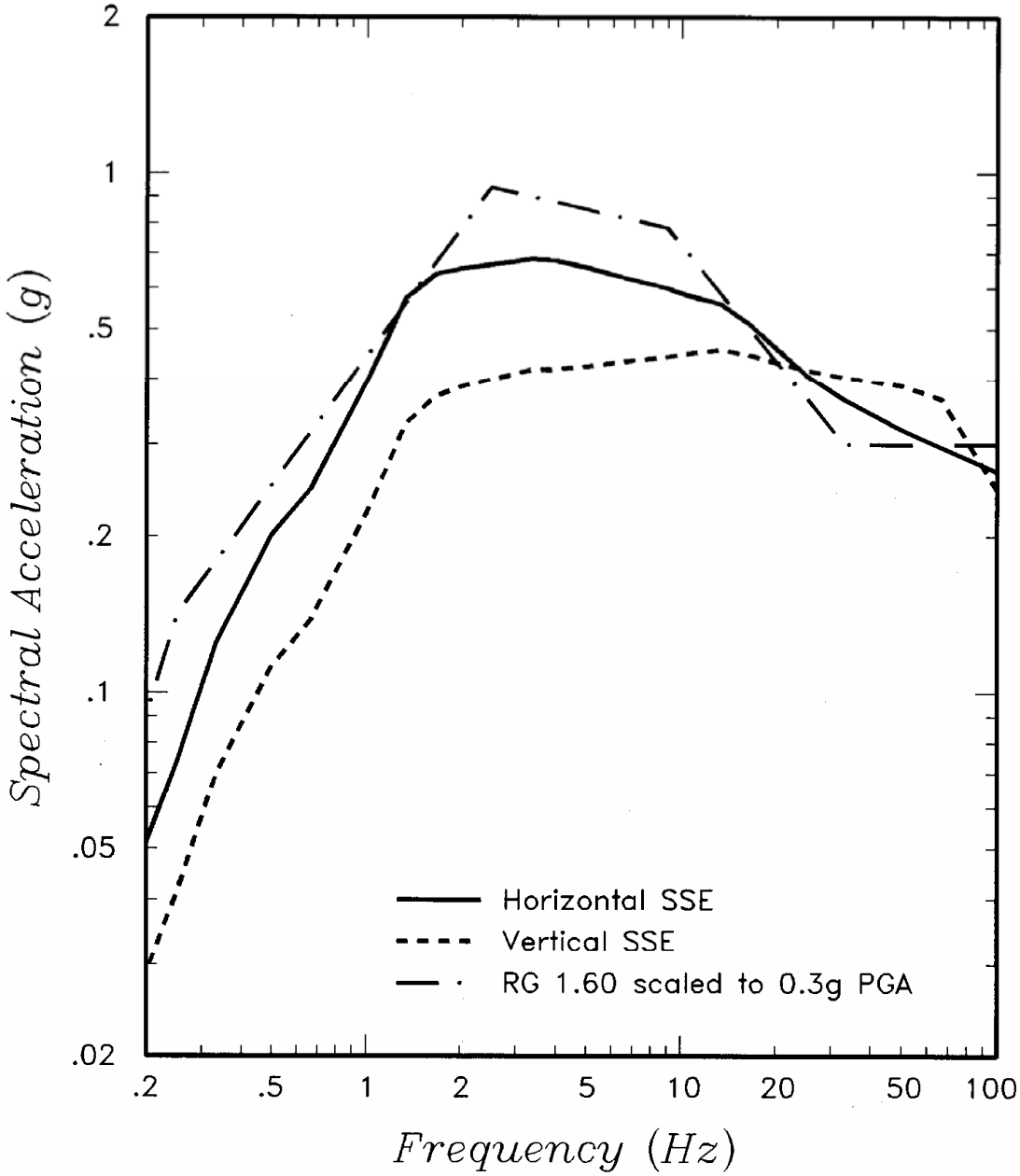


Seismic Hazards Report for the EGC ESP Site

Vertical/Horizontal Response Spectral Ratios for Rock and Soil Site Conditions Developed for Mean 10^{-4} Hazard Level at EGC ESP Site

Figure **4.3-5**

Non-GDS



Seismic Hazards Report for the EGC ESP Site

Horizontal and Vertical EGC ESP SSE Spectra

Figure
4.3-6

CHAPTER 5

Surface Faulting

This chapter describes the evidence gathered to date for faulting or the absence of faulting in the region of the EGC ESP Site. The following aspects of the geology and seismicity of the site region are discussed:

- geologic evidence, or lack thereof, for surface deformation (Section 5.1);
- earthquakes associated with capable tectonic sources (Section 5.2);
- ages of most recent deformation (Section 5.3);
- relationship between tectonic structures in the site area and regional structures (Section 5.4);
- characterization of identified capable tectonic sources (Section 5.5);
- identified zones of Quaternary deformation (Section 5.6); and
- the potential for surface tectonic deformation at the site (Section 5.7).

There is no evidence for surface faulting or fold deformation at the EGC ESP Site, and no earthquakes or capable tectonic sources have been identified within 25 miles of the site. Paleoliquefaction studies performed for this study identified locations that reveal evidence for possible paleoliquefaction (detailed in Attachment 1) possibly associated with prehistoric earthquakes. No evidence has been found for surface faulting or deformation that would pose a hazard to the EGC ESP Site. No evidence for tectonic Quaternary faulting or surface deformation was found during geologic reconnaissance for this study or in previous studies.

5.1 Geologic Evidence, or Absence of Evidence, for Surface Deformation

There is no evidence for surface faulting or fold deformation at the EGC ESP Site. Recent detailed geotechnical investigations of the site were used to develop a site-specific geologic cross section (Figure 5.1-1). Irregularities in the upper units (Illinoian glacial till and younger strata) are not reflected in the older units. In particular, the contact between a lacustrine unit and the overlying Illinoian till is flat-lying across the entire site.

5.2 Earthquakes Associated with Capable Tectonic Sources

There have been no historically reported earthquakes within 25 miles of the site that reasonably can be associated with a local structure.

Historical earthquakes have been postulated to be associated with faults and inferred structures at greater distances within the site region, as noted below. The evidence for

capable tectonic sources inferred from the historical seismicity is considered in the characterization of alternative seismic sources included in the probabilistic seismic hazard analysis (PSHA; Section 4).

A spatial association of recent small earthquakes has been postulated for the northern part of the Peru monocline (Larson, 2002). The southern part of this structure extends to within approximately 50 miles of the site (Plate 1).

The lower Wabash Valley surrounding and south of the Vincennes bend has long been recognized as slightly more active than surrounding regions. Historical earthquakes have occurred along the Commerce geophysical lineament (CGL) in this region (Langenheim and Hildenbrand, 1997). McBride et al. (2002a) report that the hypocenter for the largest historical earthquake in the site region (November 9, 1968, m_{bLg} 5.5) corresponds to the most prominent zone of dipping middle-crustal reflections, just west of the Wabash Valley fault system. McBride et al. (2002a) suggest that contemporary stress may be being released by the reactivation of Precambrian and/or Paleozoic structures. The width of the inferred fault system that underlies the CGL southwest of the Vincennes bend is approximately 1.5 to 3 miles, as imaged in deep seismic-reflection profiles (McBride et al., 2002a).

A spatial association of seismicity also is suggested along the trend of the Du Quoin monocline trend and Centralia fault zone in south-central Illinois. Su and McBride (1999) state that current deformation along this structure is suggested by earthquakes located near structural axes and having focal mechanisms consistent with strike slip along north-trending structures. These structures also are associated with a basement-involved fault, as documented from seismic-reflection profiles.

5.3 Ages of Most Recent Deformation

The evidence for possible Pleistocene and Holocene surface deformation and the association of seismicity with the structures described above suggest that there may be capable tectonic sources within the study region (the 200-mile radius of the site). The ages of most recent deformation on faults and folds within the study region are summarized on Tables 2.1-1 and 2.1-2.

Paleoliquefaction studies were conducted as part of this study to search for evidence of nearby prehistoric earthquakes. The results of these investigations (Section 2.1.4 and Attachment 1) suggest that no repeated moderate to large events (comparable to the postulated **M** 6.2 to 6.8 Springfield earthquake) occurred in the site vicinity in latest Pleistocene to Holocene time that would indicate a capable tectonic structure within 25 miles of the EGC ESP Site. The late Holocene record in particular is sufficient to demonstrate the absence of such events in the past approximately 6 to 7 ka. The latest Pleistocene/early Holocene record is less complete. The significance of the latest Pleistocene/early Holocene features recorded at location SC 25, approximately 17 miles from the site, is less certain. Only a limited number of features were found, providing insufficient information to estimate a location or magnitude if these features were caused by an earthquake. The presence of these features was considered in developing the range in maximum magnitude assigned to a random background earthquake in the probabilistic seismic hazard analysis.

5.4 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures

Recent compilations of geologic structural data for the State of Illinois (i.e., Nelson, 1995) show no faults within a 25-mile radius of the site. Folds within the La Salle anticlinorium do lie within the 25-mile radius. Based on available data, as outlined in previous studies for the CPS (Section 2.5.1.2.3 of the CPS USAR), there is no evidence for tectonic surface deformation within 25 miles of the site that is associated with these structures. No reported evidence for tectonic surface deformation in the site region was found in the recent literature.

No active faults are postulated to be associated with the folds mapped within a 25-mile radius of the site (Nelson, 1995). In other regions reverse faults in the basement, imaged in deep seismic-reflection profiles, may be associated with historical seismicity (e.g., Wabash Valley seismic zone, McBride et al., 2002a). There is, however, no recorded historical seismicity associated with folds within 25 miles of the site.

5.5 Characterization of Capable Tectonic Sources

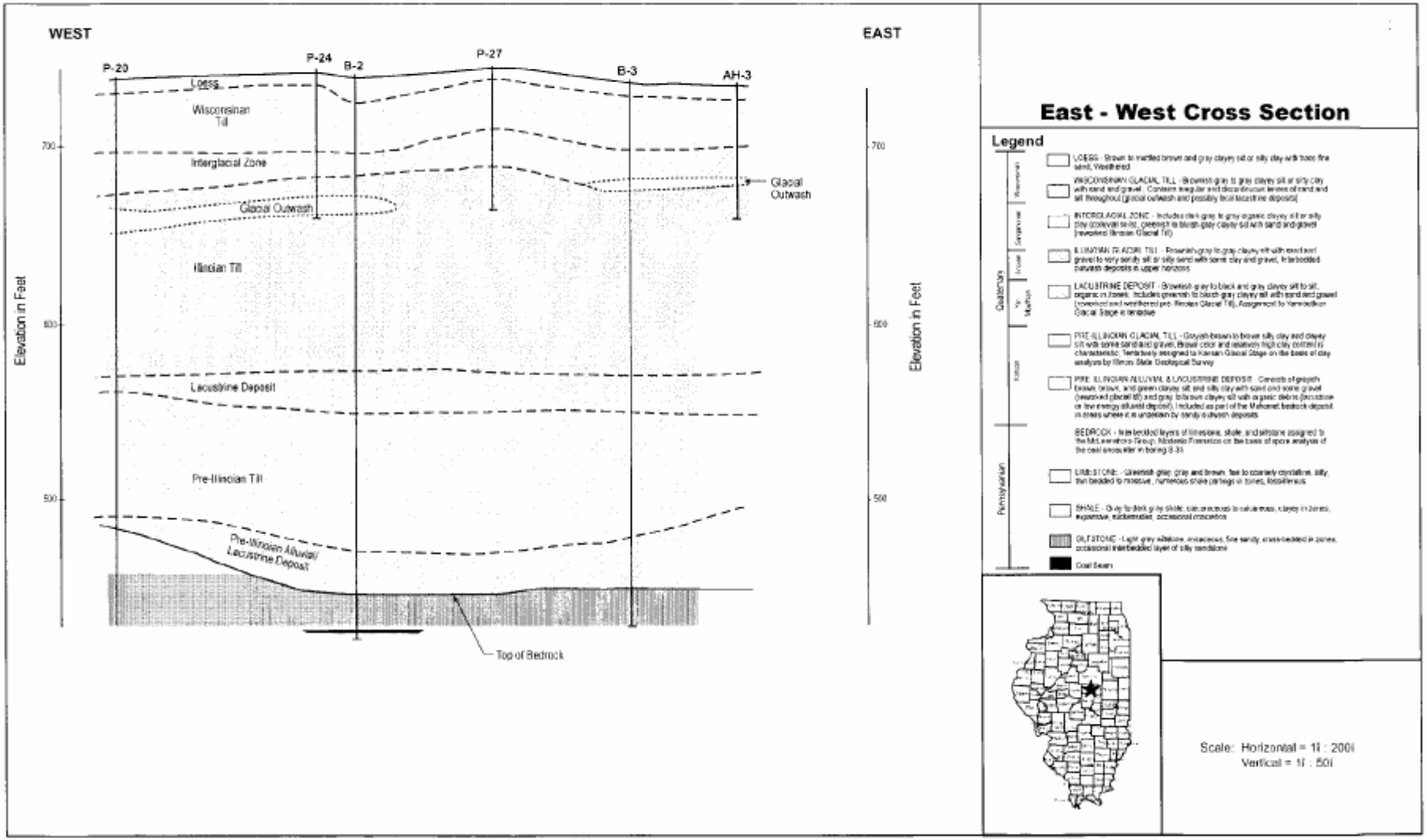
As noted in previous sections, no capable tectonic sources have been identified within 25 miles of the site.

5.6 Designation of Zones of Quaternary Deformation in Site Region

Geologic investigations of the CPS site identified no evidence of capable faulting in the site region (CPS USAR). Paleoliquefaction studies conducted in connection with the preparation of this ESP application identified locations that reveal possible evidence for paleoliquefaction (Attachment 1 to this Appendix). These features are indicative of possible seismic ground shaking associated with prehistoric earthquakes. No evidence for tectonic Quaternary faulting or surface deformation was observed during the field reconnaissance conducted along selected rivers in the study region as part of these investigations. No reported evidence for Quaternary deformation in the site region was found in the recent literature.

5.7 Potential for Surface Tectonic Deformation of Site

Previous investigations of the CPS site described in the CPS USAR, post-CPS USAR studies (e.g., published literature), and investigations conducted for this study have identified no evidence for surface faulting or deformation that would pose a hazard to the EGC ESP Site.



Seismic Hazards Report for the EGC ESP Site

Site-Specific Geologic Cross Section (from SSAR, Appendix A, 2003)

Figure **5.1-1**

CHAPTER 6

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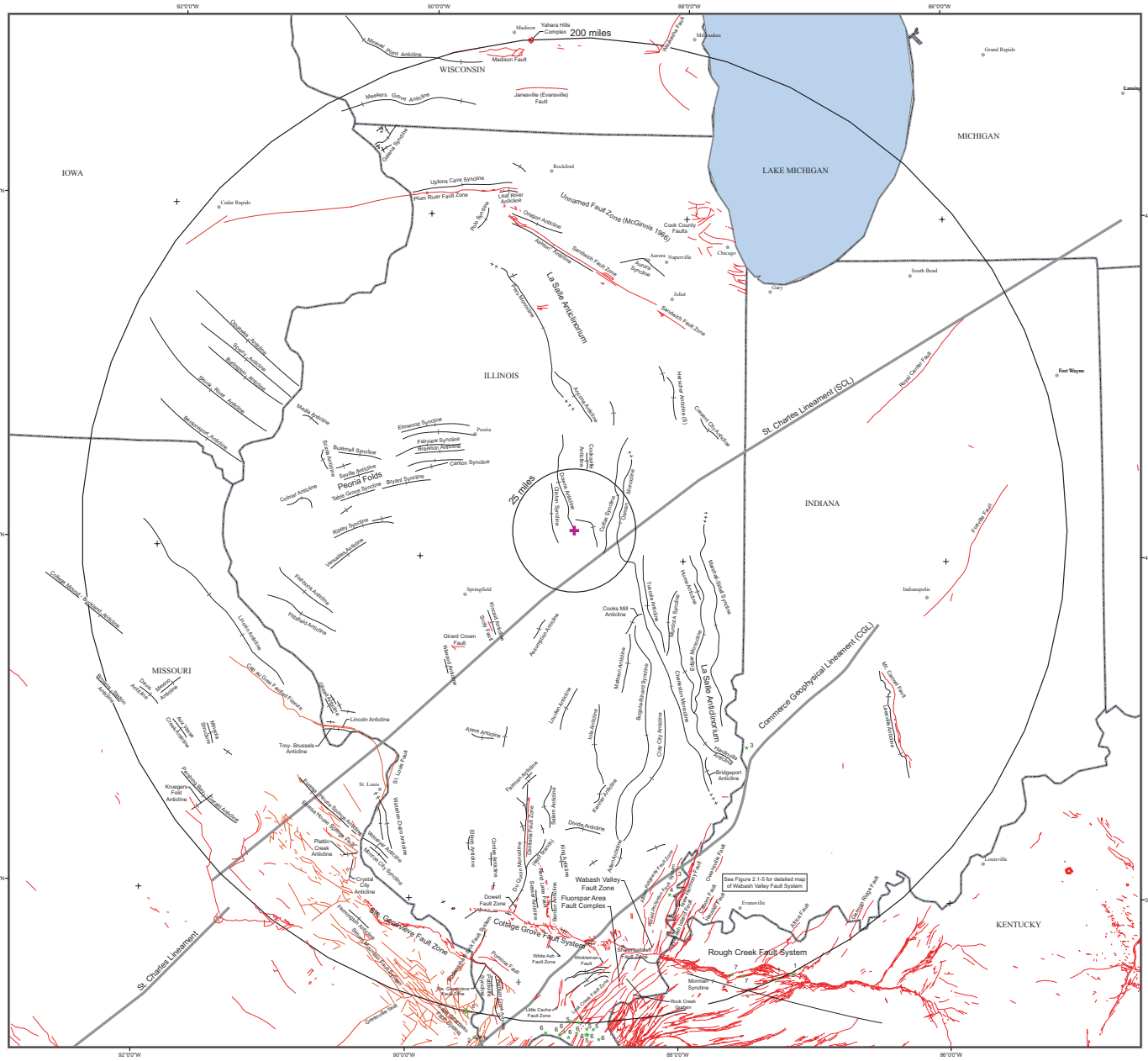

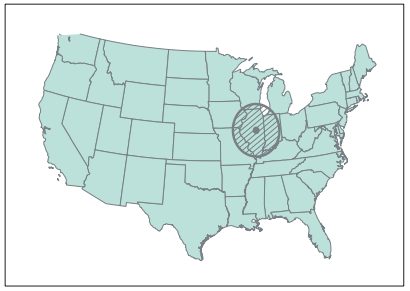

Legend

EGC ESP Site

Faults

Well documented, significant faults, faulted flexures and graben.

Folds

Well documented, significant fold structures that deform Mesozoic and older rocks.

Anticline
Syncline
Monocline

Neotectonic Point

Locations of known or suspected recent faulting or tectonic deformation. Features identified in trenches, auger holes, wells, or on the surface.

Source	Age of Youngest Deformation	Comments
1. Chadwick (1989)	Quaternary/Late Pleistocene(?)-Holocene	Possible Quaternary faulting-Bedrock offsets identified from shallow geophysics and auger hole data
2. Harrison and others (1999); Harrison and Schultz (2002)	Holocene	Recurrent Quaternary faulting: 65-50 ka, 35-25 ka, two episodes in the Holocene
3. Fraser and others (1997)	Pleistocene and Holocene	Geomorphic evidence for regional westward tilt of modern land surface (numbers indicate approximate northern and southern limbs)
4. Heigold and Larson (1994)	1811–1812	Fissures and sand blows
5. Nelson and others (1997)	Pliocene-early Pleistocene	Fluorspar Area Fault Complex from NW to SE--Lusk Creek, Raum, Hobbs Creek, and Barnes Creek fault zones and Rock Creek graben
6. Nelson and others (1999); McBride and others (2002b)	Pleistocene	Faults appear inactive for at least 55 to 128 ka
7. Stickney (1985)	Pliocene(?)-Pleistocene	Possible Quaternary faulting-Bedrock offsets identified from shallow geophysics and auger hole data
8. Harrison and Schultz (2002)	Quaternary; possible post-Sangamon (128 ka); pre-late Wisconsinan (~15 ka)	Synclinoria and faulted Quaternary deposits in graben

Geophysical Lineaments

Data Sources:
Harrison and Schultz (2002)
Hildenbrand and others (2002)
McBride and Kolata (1999)

St. Louis — Major Cities (Population greater than 100,000)

State Boundary

Sources of Map Data

Nelson (1995) (Faults and folds in Illinois)
Indiana Geological Survey (2001)
Kentucky Geological Survey (2002), Geologic Faults in Kentucky
State Geologic Faults of Missouri, Department of Geology, University of Missouri, Columbia (1991)
Harrison and Schultz (2002) (Faults and Folds in Southeastern Missouri and Southwestern Illinois)
CPS USAR, (Folds in Iowa, Wisconsin, and Missouri)
Evans et al. (2003, in preparation) (Faults in Wisconsin)
Brown et al. (2003, in preparation) (Faults in Wisconsin)

Projection: UTM, NAD 1983, Zone 16

0 10 20 40 60 80 Miles

0 20 40 60 80 100 Kilometers

Plate 1
Seismic Hazards Report for the EGC ESP Site
Structural Features Map