Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

September 12, 2013

10 CFR 50.4
10 CFR 50.54(f)

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Bellefonte Nuclear Plant, Units 1 and 2
Construction Permit Nos. CPPR-122 and CPPR-123
NRC Docket Nos. 50-438 and 50-439

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Sequoyah Nuclear Plant, Units 1 and 2
Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327 and 50-328

Watts Bar Nuclear Plant, Unit 1
Facility Operating License No. NPF-90
NRC Docket No. 50-390

Watts Bar Nuclear Plant, Unit 2
Construction Permit No. CPPR-92
NRC Docket No. 50-391

Subject: **Tennessee Valley Authority's Fleet Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident – 1.5 Year Response for CEUS Sites**

References: 1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012

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2. NRC Letter, "Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance,"" dated February 15, 2013

3. EPRI Report 1025287, "Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," 2013 Technical Report

4. NEI Letter to NRC, "Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations," dated April 9, 2013

5. NRC Letter to NEI, "EPRI Final Draft Report XXXXXX, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Near-Term Task Force Recommendation 2.1: Seismic," as an Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations," dated May 7, 2013

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to all power reactor licensees and holders of construction permits in active or deferred status. Enclosure 1 of Reference 1 requested each addressee in the Central and Eastern United States (CEUS) to submit a written response consistent with the requested seismic hazard evaluation information (items 1 through 7) by September 12, 2013. On February 15, 2013, NRC issued Reference 2, endorsing the Reference 3 industry guidance for responding to Reference 1. Section 4 of Reference 3 identifies the detailed information to be included in the seismic hazard evaluation submittals.

On April 9, 2013, Nuclear Energy Institute (NEI) submitted Reference 4 to NRC, requesting NRC agreement to delay submittal of some of the CEUS seismic hazard evaluation information so that an update to the Electric Power Research Institute (EPRI) (2004, 2006) ground motion attenuation model could be completed and used to develop that information. NEI proposed that descriptions of subsurface materials and properties and base case velocity profiles (items 3a and 3b in Section 4 of Reference 3) be submitted to NRC by September 12, 2013, with the remaining seismic hazard and screening information submitted to NRC by March 31, 2014. In Reference 5, NRC agreed with this recommendation.

The enclosure to this letter contains the requested descriptions of subsurface materials and properties and base case velocity profiles for Tennessee Valley Authority's (TVA's) Bellefonte Nuclear Plant, Browns Ferry Nuclear Plant, Sequoyah Nuclear Plant, and Watts Bar Nuclear Plant. The information provided in the enclosure to this letter is considered an interim product of seismic hazard development efforts being performed for the industry by EPRI. The complete and final seismic hazard reports for TVA will be provided to the NRC in the seismic hazard submittals by March 31, 2014, in accordance with Reference 5.

This letter contains no new regulatory commitments.

Should you have any questions concerning the content of this letter, please contact Kevin Casey at (423) 751-8523.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 12th day of September 2013.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosure: Seismic Site Descriptions for Tennessee Valley Authority's Bellefonte Nuclear Plant, Browns Ferry Nuclear Plant, Sequoyah Nuclear Plant, and Watts Bar Nuclear Plant

cc (Enclosure):

NRR Director - NRC Headquarters
NRO Director - NRC Headquarters
NRC Regional Administrator - Region II
NRR Project Manager - Bellefonte Nuclear Plant
NRR Project Manager - Browns Ferry Nuclear Plant
NRR Project Manager - Sequoyah Nuclear Plant
NRR Project Manager - Watts Bar Nuclear Plant, Unit 1
NRR Project Manager - Watts Bar Nuclear Plant, Unit 2
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
NRC Senior Resident Inspector - Sequoyah Nuclear Plant
NRC Senior Resident Inspector - Watts Bar Nuclear Plant, Unit 1
NRC Senior Resident Inspector - Watts Bar Nuclear Plant, Unit 2

ENCLOSURE

SEISMIC SITE DESCRIPTIONS FOR TENNESSEE VALLEY AUTHORITY'S BELLEFONTE NUCLEAR PLANT, BROWNS FERRY NUCLEAR PLANT, SEQUOYAH NUCLEAR PLANT AND WATTS BAR NUCLEAR PLANT

ENCLOSURE

This enclosure contains the requested descriptions of subsurface materials and properties and base case velocity profiles for Tennessee Valley Authority's (TVA) nuclear sites. These descriptions were provided by Electric Power Research Institute (EPRI) in support of the NRC March 12, 2012, 10 CFR 50.54(f) Request for Information letter regarding seismic aspect of Recommendation 2.1.

The attachments to this enclosure provide the descriptions for the respective site:

Attachment 1 - Bellefonte Nuclear Plant Site Description
Attachment 2 - Browns Ferry Nuclear Plant Site Description
Attachment 3 - Sequoyah Nuclear Plant Description
Attachment 4 - Watts Bar Nuclear Plant Description

Note, in Attachment 2 and 3 Table 1A, "Summary of Geotechnical Profile Data," for Browns Ferry Nuclear Plant (BFN) and Sequoyah Nuclear Plant (SQN), both sites did not have readily available measured shear strain data for alluvial clays and silts over residual clays and silts. The alluvial clays and silts seen in the Tennessee River Valley are similar; therefore, the referenced Watts Bar Final Safety Analysis Report (FSAR) Figures shear strain data was utilized for both BFN and SQN descriptions. Since BFN and SQN have limited and indirect data on shear wave velocities, multiple profiles or base cases have been developed to account for epistemic uncertainty in alignment with EPRI Technical Report 1025287, "Seismic Evaluation Guidance," Section 2.4.1 and Appendix B.

Attachment 1
Bellefonte Nuclear Plant Site Description

The basic information used to evaluate the site geologic profile at the Bellefonte site is shown in Table 1. The basis for this profile information is given in Reference 1. The site geologic profile indicates that hard rock (shear-wave velocity generally exceeding 9200 ft/sec) underlies the site. As a result, the Bellefonte site was treated as a hard-rock site and no site amplification factors were calculated for the site.

References

1. Bechtel Corp (2012). *Dynamic Soil Column for Unit 1 Reactor Building,* Bechtel calculation 25644-012-K0C-CY05-00014 dated 10/1/12 (transmitted by letter dated 10/17/12 from Matyas to Birchell).

Attachment 1 Table 1

Summary of Geotechnical Profile for Bellefonte Unit 1 Reactor Building

Depth Range, ft	Elevation Range, ft	Control Point	Lithologic Unit	General Rock Description	Total Unit Weight, pcf	Shear Wave Velocity, fps	Compression Wave Velocity, fps	Poisson's Ratio
0 – 34	646 - 612	Ground Surface Elevation at 646 ft	Backfill	Reddish brown highly plastic clay with trace to little amounts of sand and gravel	124	810 ± 300	1,980	0.4
34 – 81	612 – 565	Foundation Elevation at 612 ft	MSR Unit A	Medium gray limestone (micrite and wackestone) with interbeds of dark gray argillaceous and silty limestone	170 ± 2	9,210 ± 380	17,850 ± 970	0.316 ± 0.024
81 – 206	565 – 440		MSR Unit B	Medium gray limestone (micrite, packstone, and wackestone) with dark gray, wavy dolomitic laminae	170 ± 2	10,320 ± 580	19,390 ± 1,170	0.300 ± 0.027
206 – 278	440 – 368		MSR Unit C	Dark gray argillaceous and silty dolomitic limestone with interbeds of medium gray dolomitic limestone	155 ± 10	8,180 ± 1,000	15,680 ± 1,610	0.312 ± 0.025
278 - 416	368 - 230		MSR Unit D	Medium gray limestone with dark gray, wavy dolomitic laminae	170 ± 2	10,600 ± 320	20,000 ± 990	0.303 ± 0.022

NOTES:
1. MSR – Middle Stones River.
2. Top of rock profile at Unit 1 Reactor Building, El 612 ft.
3. Ground surface elevation near the Unit 1 Reactor Building is 646 ft.
4. Groundwater level elevation at 625 ft.
5. Shear and compression wave velocity data for rock from P-S suspension logging, Reference 1.
6. Shear wave velocity data for backfill from seismic CPT logging, Reference 1.
7. General rock descriptions from Reference 3.
8. Best estimate and range values provided for unit weight, velocity, and Poisson's ratio.

Attachment 2
Browns Ferry Nuclear Plant Site Description

The basic information used to create the site geologic profile at the Browns Ferry Nuclear Plant is shown in Tables 1A and 1B. This profile was developed using information documented in Reference 1. As indicated in Table 1A, the SSE Control Point is at a depth of 52 ft., and the profile was modeled up to this location. For dynamic properties of soft rock layers, modulus and damping curves were represented with 2 models. The first model used rock curves taken from Reference 2, the second model assumed linear behavior. These dynamic property models were weighted equally.

The 3 base-case shear-wave velocity profiles used to model amplification at the site are shown in Figure 1. Profiles 1, 2, and 3 are weighted 0.4, 0.3, and 0.3, respectively. Thicknesses, depths, and shear-wave velocities (Vs) corresponding to each profile are shown in Table 2.

<u>References</u>

1. AMEC (2013). *Seismic Data Retrieval Information for EPRI Near Term Task Force Recommendation 2.1 TVA Browns Ferry Nuclear Plant Athens, Alabama,* AMEC Project 3043121013 report transmitted by letter from K. Campbell to M. Best on June 26, 2013.

2. EPRI (1993). *Guidelines for Determining Design Basis Ground Motions*, Elec. Power Res. Inst., Palo Alto, CA, Rept. TR-102293, Vol. 1-5.

Attachment 2 Table 1A

Summary of Geotechnical Profile Data for Browns Ferry Nuclear Plant

Depth (feet)	Soil/Rock Description	Density (pcf)	Measured V_s (fps)	Recommended V_s for Analyses (fps)	Gmax (psf)	G/Gmax vs. Shear Strain	Damping Ratio vs. Shear Strain
0	Ground Surface Elev. 565 – **Control Point for GMRS**	---	---	---	---	---	---
0 - 50	Alluvial Clays, Silts over Residual Clays, Silts**	120	700 – 1,800 Average 1,067	1,050	4,000,000	Use Watts Bar FSAR Figure 2.5-233E	Use Watts Bar FSAR Figure 2.5-233F
50 - 52	Dolomite and Limestone	165	---	8,000*	330,000,000	1	No Change
52	**Deepest Structure Foundation Control Point – SSE GMRS**	---	---	---	---	---	---
52 - 100	Dolomite and Limestone	165	---	8,000	330,000,000	1	No Change
100 - 200	Fossiliferous Chert	165	---	8,000	330,000,000	1	No Change

Notes:
* Calculated from laboratory measured Shear Modulus, G
** Replaced with engineered backfill for safety-related structures.

Attachment 2 Table 1B

Summary of Geologic Profile for Browns Ferry Nuclear Plant Extended to Basement

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
0-50	Overburden, alluvial clays, silts over residual clays, silts. Thickness 0 to 50 feet.	Mt – Tuscumbia Limestone	1050****	700****	1800****
50-250	Limestone, light gray, thin- to medium-bedded, siliceous with nodules of light to dark gray fossiliferous chert; lower part of unit locally siliceous dark gray shale. Thickness 100 to 200 feet.	Mfp – Fort Payne Chert	9500	7600	9285
250-325	Shale, black to gray, carbonaceous, radioactive, pyritiferous, fissile. Weathers to a greenish gray soil. Thickness 0 to 66 feet.	Dc – Chattanooga Shale	7000	5600	8750
325-1025	Shale and siltstone with thin limestone, gray to reddish-gray, contains one or more hematite rich ore beds in lower half; shale and siltstone interbedded with light green or gray, thick-bedded sandstone in upper half. Thick, light gray limestone unit near middle of interval. Thickness 300 to 700 feet.	Srm – Red Mountain Formation	7000	5600	8750
1025-1225	Limestone, light to dark gray, thin- to medium-bedded, fine grained, highly argillaceous and fossiliferous, interbedded with variegated greenish-gray and maroon calcareous shale. Thickness about 200 feet.	Os – Sequatchie Formation	9500	6050	9285
1225-1825	Limestone, light to medium gray, cryptocrystalline to coarsely crystalline, slabby to medium- bedded, argillaceous in part; numerous thin bentonite layers. Bentonites separate Unit I from Unit II. Thickness 200 to 600 feet.	Oc – Chickamauga Group	9500	6050	9285
1825-3425	Dolomite and minor limestone, very siliceous, light- to dark-gray, fine- to coarse-grained, thin- to thick-bedded, weathers to cherty rubble. Thickness about 2,600 feet.	OЄk – Knox Group, Undifferentiated	7000	4460	9285

Attachment 2 Table 1B
(continued)

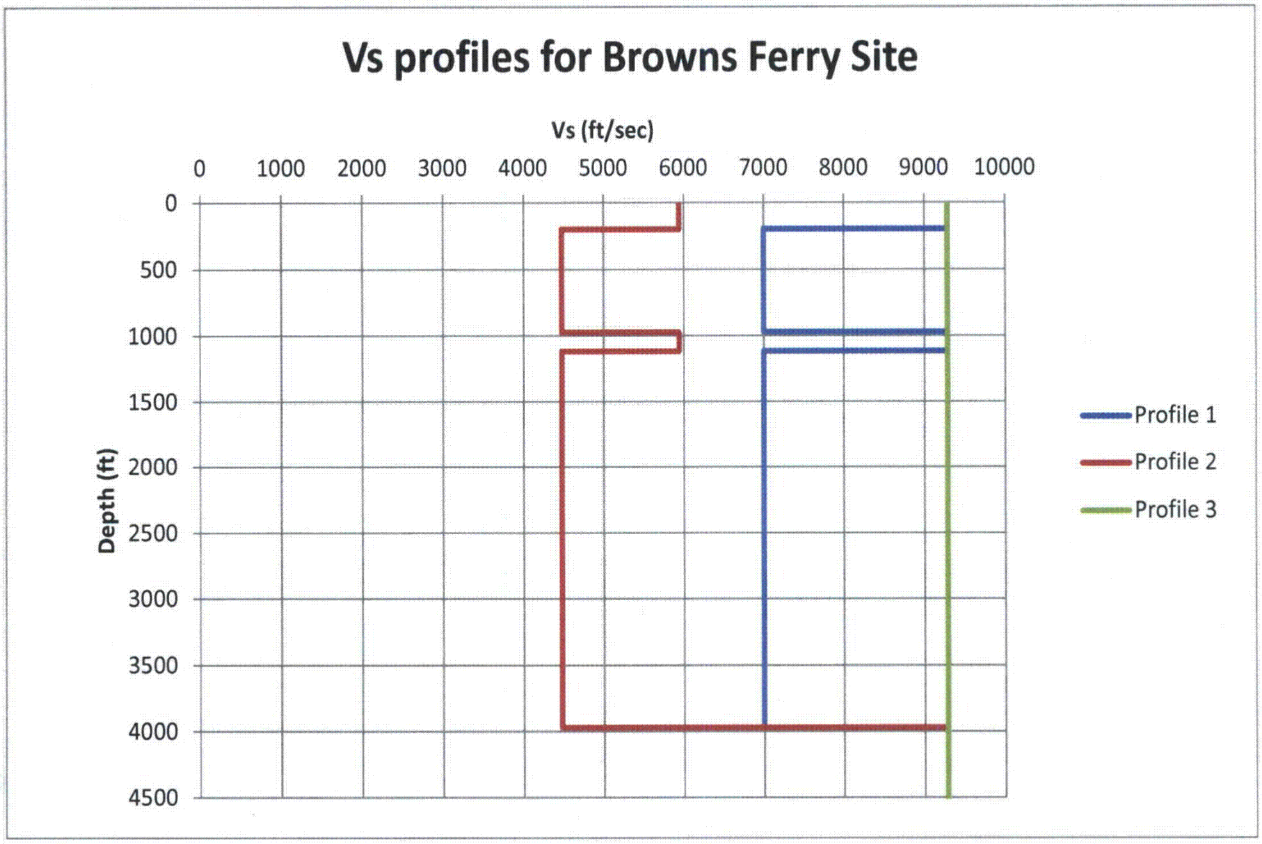
Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
3425-4025	Shale, gray and greenish-gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin- bedded, edgewise conglomerates consisting of dolomitic rip-up clasts throughout the middle and upper part of the formation. Lower part consists of interbedded siltstone, and shale, gray and greenish-gray, thin-bedded, glauconitic, micaceous, commonly bioturbated, a few marine shell fossils found.	Ꞓc – Conasauga Group Lower Undivided	7000	4460	9285
4025-4200	Sandstone, reddish-brown, greenish-gray, light-brown, olive, fine-to medium-grained, thin-to thick-bedded, glauconitic, micaceous; interbedded with shale and siltstone, reddish- brown, olive greenish-gray, light-brown, thin-bedded, micaceous, bioturbated; dolomite and dolomoitic limestone may also be present; thrust fault at base, estimated exposed thickness shown.	Ꞓr – Rome Formation	10,000	6370	9285
> 4200	-	Basement	12,000	7640	9285

*Note: Rock Descriptions obtained from "Stratigraphic Succession Along the Appalachian Structural Front in Alabama," dated 1969, Drahovzal and Neathery; and from the Geologic Map of the Decatur Quadrangle, dated 2008, Lemiszki, Kohl, and Sutton

**Note: These values were based on SASW testing by Dr. Ken Stokoe at the Watts Bar nuclear plant site, which consists of similar rock formation to base these values upon. Ivan Wong from URS assisted Dr. Stokoe and AMEC in developing a lognormal average for the best estimate.

***Note: The lower and upper ranges were based on the best estimate, with the upper range constrained not to exceed 9285 fps. For depths of 0–50 ft, these values were calculated using a Vs value for limestone of 9500 fps and a certainty of 1.25. For depths of 50–1000 ft, these values were calculated using a certainty of 1.25. For depths of 1000 ft to basement, these values were calculated using a certainty of 1.57.

****Note: These values were not determined by the same methods outlined in **Note and ***Note. These values were obtained from the previous geotechnical exploration shown in Table 1.



Attachment 2 Figure 1. Vs profiles for Browns Ferry site

Attachment 2 Table 2

Layer thicknesses, depths, and Vs for 3 profiles, Browns Ferry site

Profile 1			Profile 2			Profile 3		
thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)
	0	9285		0	5942		0	9285
10.0	10.0	9285	10.0	10.0	5942	10.0	10.0	9285
10.0	20.0	9285	10.0	20.0	5942	10.0	20.0	9285
8.0	28.0	9285	8.0	28.0	5942	8.0	28.0	9285
10.0	38.0	9285	10.0	38.0	5942	10.0	38.0	9285
10.0	48.0	9285	10.0	48.0	5942	10.0	48.0	9285
2.0	50.0	9285	2.0	50.0	5942	2.0	50.0	9285
10.0	60.0	9285	10.0	60.0	5942	10.0	60.0	9285
10.0	70.0	9285	10.0	70.0	5942	10.0	70.0	9285
10.0	80.0	9285	10.0	80.0	5942	10.0	80.0	9285
10.0	90.0	9285	10.0	90.0	5942	10.0	90.0	9285
10.0	100.0	9285	10.0	100.0	5942	10.0	100.0	9285
10.0	110.0	9285	10.0	110.0	5942	10.0	110.0	9285
10.0	120.0	9285	10.0	120.0	5942	10.0	120.0	9285
10.0	130.0	9285	10.0	130.0	5942	10.0	130.0	9285
10.0	140.0	9285	10.0	140.0	5942	10.0	140.0	9285
8.0	148.0	9285	8.0	148.0	5942	8.0	148.0	9285
2.0	150.0	9285	2.0	150.0	5942	2.0	150.0	9285
10.0	160.0	9285	10.0	160.0	5942	10.0	160.0	9285
10.0	170.0	9285	10.0	170.0	5942	10.0	170.0	9285
10.0	180.0	9285	10.0	180.0	5942	10.0	180.0	9285
10.0	190.0	9285	10.0	190.0	5942	10.0	190.0	9285
8.0	198.0	9285	8.0	198.0	5942	10.0	200.0	9285
10.0	208.0	7000	10.0	208.0	4480	10.0	210.0	9285
10.0	218.0	7000	10.0	218.0	4480	10.0	220.0	9285
10.0	228.0	7000	10.0	228.0	4480	10.0	230.0	9285
10.0	238.0	7000	10.0	238.0	4480	10.0	240.0	9285
10.0	248.0	7000	10.0	248.0	4480	10.0	250.0	9285
10.0	258.0	7000	10.0	258.0	4480	10.0	260.0	9285
10.0	268.0	7000	10.0	268.0	4480	10.0	270.0	9285
10.0	278.0	7000	10.0	278.0	4480	10.0	280.0	9285
10.0	288.0	7000	10.0	288.0	4480	10.0	290.0	9285
10.0	298.0	7000	10.0	298.0	4480	10.0	300.0	9285
10.0	308.0	7000	10.0	308.0	4480	10.0	310.0	9285
10.0	318.0	7000	10.0	318.0	4480	10.0	320.0	9285
10.0	328.0	7000	10.0	328.0	4480	10.0	330.0	9285

Attachment 2 Table 2
(continued)

Profile 1			Profile 2			Profile 3		
thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)
10.0	338.0	7000	10.0	338.0	4480	10.0	340.0	9285
10.0	348.0	7000	10.0	348.0	4480	10.0	350.0	9285
10.0	358.0	7000	10.0	358.0	4480	10.0	360.0	9285
10.0	368.0	7000	10.0	368.0	4480	10.0	370.0	9285
10.0	378.0	7000	10.0	378.0	4480	10.0	380.0	9285
10.0	388.0	7000	10.0	388.0	4480	10.0	390.0	9285
10.0	398.0	7000	10.0	398.0	4480	10.0	400.0	9285
10.0	408.0	7000	10.0	408.0	4480	10.0	410.0	9285
10.0	418.0	7000	10.0	418.0	4480	10.0	420.0	9285
10.0	428.0	7000	10.0	428.0	4480	10.0	430.0	9285
10.0	438.0	7000	10.0	438.0	4480	10.0	440.0	9285
10.0	448.0	7000	10.0	448.0	4480	10.0	450.0	9285
10.0	458.0	7000	10.0	458.0	4480	10.0	460.0	9285
10.0	468.0	7000	10.0	468.0	4480	10.0	470.0	9285
10.0	478.0	7000	10.0	478.0	4480	10.0	480.0	9285
10.0	488.0	7000	10.0	488.0	4480	10.0	490.0	9285
10.0	498.0	7000	10.0	498.0	4480	10.0	500.0	9285
40.8	538.8	7000	40.8	538.8	4480	40.8	540.8	9285
40.8	579.6	7000	40.8	579.6	4480	40.8	581.6	9285
40.8	620.4	7000	40.8	620.4	4480	40.8	622.4	9285
40.8	661.2	7000	40.8	661.2	4480	40.8	663.2	9285
40.8	702.0	7000	40.8	702.0	4480	40.8	704.0	9285
40.8	742.8	7000	40.8	742.8	4480	40.8	744.8	9285
40.8	783.6	7000	40.8	783.6	4480	40.8	785.6	9285
40.8	824.4	7000	40.8	824.4	4480	40.8	826.4	9285
40.8	865.2	7000	40.8	865.2	4480	40.8	867.2	9285
40.8	906.0	7000	40.8	906.0	4480	40.8	908.0	9285
67.0	973.0	7000	67.0	973.0	4480	409.2	1317.1	9285
71.9	1044.9	9285	71.9	1044.9	5942	409.2	1726.3	9285
71.9	1116.7	9285	71.9	1116.7	5942	409.2	2135.5	9285
401.4	1518.1	7000	401.4	1518.1	4480	409.2	2544.7	9285
408.9	1927.0	7000	408.9	1927.0	4480	409.2	2953.9	9285
409.2	2336.2	7000	409.2	2336.2	4480	409.2	3363.0	9285
409.2	2745.3	7000	409.2	2745.3	4480	409.2	3772.2	9285
409.2	3154.5	7000	409.2	3154.5	4480	409.2	4181.4	9285
409.2	3563.7	7000	409.2	3563.7	4480	409.2	4590.6	9285
409.2	3972.9	7000	409.2	3972.9	4480	409.2	4999.8	9285

Attachment 2 Table 2
(continued)

Profile 1			Profile 2			Profile 3		
thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)
3280.8	7253.7	9285	3280.8	7253.7	9285	3280.8	8280.6	9285

Attachment 3
Sequoyah Nuclear Plant Site Description

The basic information used to create the site geologic profile at the Sequoyah Nuclear Plant is shown in Tables 1A and 1B. This profile was developed using information documented in Reference 1. As indicated in Reference 1, the SSE Control Point is at a depth of 64 ft., and the profile was modeled up to this location. For dynamic properties of soft rock layers, modulus and damping curves were represented with 2 models. The first model used rock curves taken from Reference 2, the second model assumed linear behavior. These dynamic property models were weighted equally.

The 3 base-case shear-wave velocity profiles used to model amplification at the site are shown in Figure 1. Profiles 1, 2, and 3 are weighted 0.4, 0.3, and 0.3, respectively. Thicknesses, depths, and shear-wave velocities (Vs) corresponding to each profile are shown in Table 2.

<u>References</u>

1. AMEC (2013). *Seismic Data Retrieval Information for EPRI Near Term Task Force Recommendation 2.1 TVA Sequoyah Nuclear Plant Soddy Daisy, Tennessee,* Letter report, AMEC Proj. 3043132002, Letter from K. Campbell to M. Jones dated June 26, 2013.

2. EPRI (1993). *Guidelines for Determining Design Basis Ground Motions*, Elec. Power Res. Inst., Palo Alto, CA, Rept. TR-102293, Vol. 1-5.

Attachment 3 Table 1A

Summary of Geotechnical Profile Data for Sequoyah Nuclear Plant

Depth (feet)	Soil/Rock Description	Density (pcf)	Measured V_s* (fps)	V_s for Analyses (fps)	Gmax (psf)	G/Gmax vs. Shear Strain	Damping Ratio vs. Shear Strain
0	Ground Surface Elev. 705	-	-	-	-	-	-
0-38	Residual Clays and Silts**	115	442 – 3,050 Average 1,180	1,200	3,700,000	Use Watts Bar FSAR Figure 2.5-233E	Use Watts Bar FSAR Figure 2.5-233F
38-64	Limestone with interbedded Shale	170	4,873 – 9,697 Average 6,723	6,700 (±1,000)	237,000,000	1	No Change
64	**Deepest Structure Foundation Control Point – SSE GMRS**	-	-	-	-	-	-
64-103	Limestone with interbedded Shale	170	4,873 – 9,697 Average 6,723	6,700 (±1,000)	237,000,000	1	No Change

* The range of shear wave velocities measured in various geophysical tests performed at the site.

** Replaced with engineered backfill for safety related structures.

Attachment 3 Table 1B

Summary of Geologic Profile for Sequoyah Nuclear Plant Extended to Basement

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate Vs (fps)**	Lower Range Vs (fps)***	Upper Range Vs (fps)***
0-1500	Shale, light-green to brown; limestone, medium-gray, dolomitic, coarse-grained, oolitic, and commonly conglomeratic; lower part consists of shale and siltstone.	Ꞓc – Conasauga Group, Undivided	6000	4800	7500
-	-	Kingston Fault			
1500-1650	Upper part consists of greenish-gray and grayish-red calcisiltite and claystone. Lower part is a light-gray, thick-bedded calcilutite. A basal conglomerate, occurring locally, is slight greenish- to reddish- gray dolosiltite, with thin- to medium-bedded, light greenish- gray *calcilutite and calcisiltite*, or lenses of shale and sandstone.	Ops – Pond Spring Formation	9500	6050	9285
1650-4800	Dolomite and minor limestone, very siliceous, light- to dark-gray, fine- to coarse-grained, thin- to thick- bedded, weathers to cherty rubble. Thickness about 2,600 feet.	OꞒk – Knox Group, Undifferentiated	7000	4460	9285
4800-6250	Shale, light-green to brown; limestone, medium-gray, dolomitic, coarse-grained, oolitic, and commonly conglomeratic; lower part consists of shale and siltstone.	Ꞓc – Conasauga Group, Undivided	7000	4460	9285
6250-7580	Consists of sandstone, siltstone, and shale. Formation not exposed; shown in structure section only.	Ꞓr – Rome Formation	10,000	6370	9285
-	-	Chattanooga Fault			
7580-9700	Dolomite and minor limestone, very siliceous, light- to dark-gray, fine- to coarse-grained, thin- to thick- bedded, weathers to cherty rubble. Thickness about 2,600 feet.	OꞒk – Knox Group, Undifferentiated	7000	4460	9285
9700-11,150	Shale, light-green to brown; limestone, medium-gray, dolomitic, coarse-grained, oolitic, and commonly conglomeratic; lower part consists of shale and siltstone.	Ꞓc – Conasauga Group, Undivided	7000	4460	9285

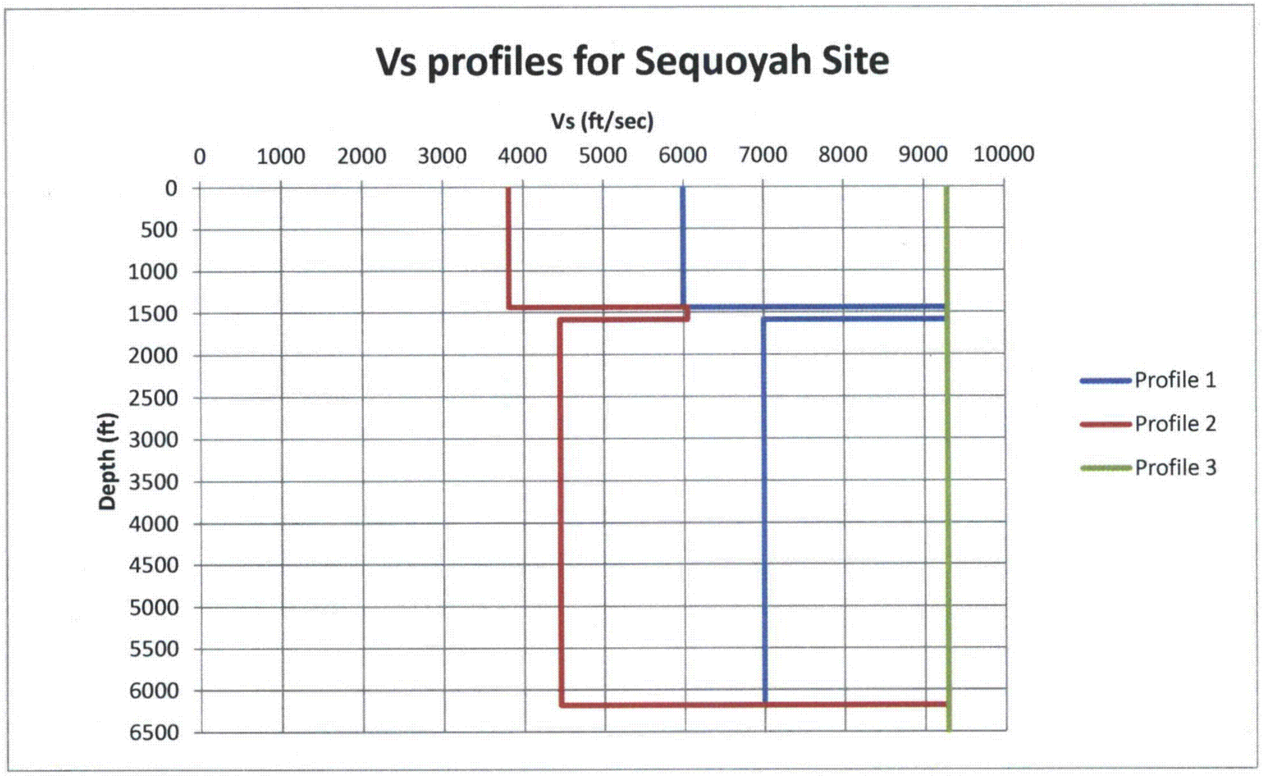
Attachment 3 Table 1B
(continued)

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
11,150-11,900	Consists of sandstone, siltstone, and shale. Formation not exposed; shown in structure section only.	Ꞓr – Rome Formation	10,000	6370	9285
-	-	Sequatchie Valley Fault			
11,900-12,350	Consists of sandstone, siltstone, and shale. Formation not exposed; shown in structure section only.	Ꞓr – Rome Formation	10,000	6370	9285
>12,350	-	Basement	12,000	7640	9285

*Note: Rock Descriptions obtained from "Stratigraphic Succession Along the Appalachian Structural Front in Alabama," dated 1969, Drahovzal and Neathery; and from the Geologic Map of the Decatur Quadrangle, dated 2008, Lemiszki, Kohl, and Sutton

**Note: These values were based on SASW testing by Dr. Ken Stokoe at the Watts Bar nuclear plant site, which consists of similar rock formation to base these values upon. Ivan Wong from URS assisted Dr. Stokoe and AMEC in developing a lognormal average for the best estimate.

***Note: The lower and upper ranges were based on the best estimate, with the upper range constrained not to exceed 9285 fps. For depths of 0–1500 ft, these values were calculated using a certainty of 1.25. For depths of 1500 ft to basement, these values were calculated using a certainty of 1.57.



Attachment 3 Figure 1. Vs profiles for Sequoyah site

Attachment 3 Table 2

Layer thicknesses, depths, and Vs for 3 profiles, Sequoyah site

Profile 1			Profile 2			Profile 3		
thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)
	0	6000		0	3821		0	9285
6.7	6.7	6000	6.7	6.7	3821	6.7	6.7	9285
6.7	13.3	6000	6.7	13.3	3821	6.7	13.3	9285
6.7	20.0	6000	6.7	20.0	3821	6.7	20.0	9285
10.0	30.0	6000	10.0	30.0	3821	10.0	30.0	9285
10.0	40.0	6000	10.0	40.0	3821	10.0	40.0	9285
10.0	50.0	6000	10.0	50.0	3821	10.0	50.0	9285
10.0	60.0	6000	10.0	60.0	3821	10.0	60.0	9285
10.0	70.0	6000	10.0	70.0	3821	10.0	70.0	9285
10.0	80.0	6000	10.0	80.0	3821	10.0	80.0	9285
10.0	90.0	6000	10.0	90.0	3821	10.0	90.0	9285
10.0	100.0	6000	10.0	100.0	3821	10.0	100.0	9285
10.0	110.0	6000	10.0	110.0	3821	10.0	110.0	9285
10.0	120.0	6000	10.0	120.0	3821	10.0	120.0	9285
13.0	133.0	6000	13.0	133.0	3821	13.0	133.0	9285
13.0	146.0	6000	13.0	146.0	3821	13.0	146.0	9285
13.0	159.0	6000	13.0	159.0	3821	13.0	159.0	9285
13.0	172.0	6000	13.0	172.0	3821	13.0	172.0	9285
13.0	185.0	6000	13.0	185.0	3821	13.0	185.0	9285
13.0	198.0	6000	13.0	198.0	3821	13.0	198.0	9285
13.0	211.0	6000	13.0	211.0	3821	13.0	211.0	9285
13.0	224.0	6000	13.0	224.0	3821	13.0	224.0	9285
13.0	237.0	6000	13.0	237.0	3821	13.0	237.0	9285
13.0	250.0	6000	13.0	250.0	3821	13.0	250.0	9285
25.0	275.0	6000	25.0	275.0	3821	25.0	275.0	9285
25.0	300.0	6000	25.0	300.0	3821	25.0	300.0	9285
25.0	325.0	6000	25.0	325.0	3821	25.0	325.0	9285
25.0	350.0	6000	25.0	350.0	3821	25.0	350.0	9285
25.0	375.0	6000	25.0	375.0	3821	25.0	375.0	9285
25.0	400.0	6000	25.0	400.0	3821	25.0	400.0	9285
25.0	425.0	6000	25.0	425.0	3821	25.0	425.0	9285
25.0	450.0	6000	25.0	450.0	3821	25.0	450.0	9285
25.0	475.0	6000	25.0	475.0	3821	25.0	475.0	9285
25.0	500.0	6000	25.0	500.0	3821	25.0	500.0	9285
36.0	536.0	6000	36.0	536.0	3821	36.0	536.0	9285

Attachment 3 Table 2
(continued)

Profile 1			Profile 2			Profile 3		
thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)
225.0	761.0	6000	225.0	761.0	3821	225.0	761.0	9285
225.0	985.9	6000	225.0	985.9	3821	225.0	985.9	9285
225.0	1210.9	6000	225.0	1210.9	3821	225.0	1210.9	9285
225.0	1435.9	6000	225.0	1435.9	3821	225.0	1435.9	9285
75.0	1510.9	9285	75.0	1510.9	6051	75.0	1510.9	9285
75.0	1585.9	9285	75.0	1585.9	6051	75.0	1585.9	9285
225.0	1810.9	7000	225.0	1810.9	4458	225.0	1810.9	9285
225.0	2035.9	7000	225.0	2035.9	4458	225.0	2035.9	9285
225.0	2260.9	7000	225.0	2260.9	4458	225.0	2260.9	9285
225.0	2485.9	7000	225.0	2485.9	4458	225.0	2485.9	9285
225.0	2710.9	7000	225.0	2710.9	4458	225.0	2710.9	9285
225.0	2935.8	7000	225.0	2935.8	4458	225.0	2935.8	9285
225.0	3160.8	7000	225.0	3160.8	4458	225.0	3160.8	9285
225.0	3385.8	7000	225.0	3385.8	4458	225.0	3385.8	9285
553.1	3938.9	7000	553.1	3938.9	4458	553.1	3938.9	9285
553.1	4492.0	7000	553.1	4492.0	4458	553.1	4492.0	9285
553.1	5045.0	7000	553.1	5045.0	4458	553.1	5045.0	9285
553.1	5598.1	7000	553.1	5598.1	4458	553.1	5598.1	9285
587.5	6185.6	7000	587.5	6185.6	4458	587.5	6185.6	9285
3280.8	9466.5	9285	3280.8	9466.5	9285	3280.8	9466.5	9285

Attachment 4
Watts Bar Nuclear Plant Site Description

The basic information used to create the site geologic profile at the Watts Bar Nuclear Plant is shown in Tables 1A and 1B. This profile was developed using information documented in Reference 1. As indicated in Table 1A, the SSE Control Point is at a depth of 64 ft., and the profile was modeled up to this depth. For dynamic properties of soft rock layers, modulus and damping curves were represented with 2 models. The first model used rock curves taken from Reference 2, the second model assumed linear behavior. These dynamic property models were weighted equally.

The 3 base-case shear-wave velocity profiles used to model amplification at the site are shown in Figure 1. Profiles 1, 2, and 3 are weighted 0.4, 0.3, and 0.3, respectively. Thicknesses, depths, and shear-wave velocities (Vs) corresponding to each profile are shown in Table 2.

<u>References</u>

1. AMEC (2013). *Seismic Data Retrieval Information for EPRI Near Term Task Force Recommendation 2.1 TVA Watts Bar Nuclear Plant Spring City, Tennessee,* Letter report, AMEC Proj. 3043121029, Letter from K. Campbell to B. Enis dated June 26, 2013.

2. EPRI (1993). *Guidelines for Determining Design Basis Ground Motions*, Elec. Power Res. Inst., Palo Alto, CA, Rept. TR-102293, Vol. 1-5.

Attachment 4 Table 1A

Summary of Geotechnical Profile Data for Watts Bar Nuclear Power Plant

Depth (feet)	Soil/Rock Description	Density (pcf)	Measured V_s* (fps)	V_s for Analyses (fps)	Gmax (psf)	G/Gmax vs. Shear Strain	Damping Ratio vs. Shear Strain
0	Ground Surface Elev. 728	-	-	-	-	-	-
0 - 32	In-situ Clays, Silts, Sand and Gravel**	120	700 - 1,830	1,200	6,500,000	FSAR Figure 2.5-233E	FSAR Figure 2.5-233F
32 - 64	Interbedded Shales and Limestones	165	4,160 - 8,341	5,000 - 7,000	200,000,000	1	No Change
64	**Deepest Structure Foundation Control Point – SSE GMRS**	-	-	-	-	-	-
64 - 180	Interbedded Shales and Limestones	165	4,160 - 8,341	5,000 - 7,000	200,000,000	1	No Change

Note –* The range of shear wave velocities measured in various geophysical tests performed at the site.
** Replaced with engineered backfill for safety related structures.

Attachment 4 Table 1B

Summary of Geologic Profile for Watts Bar Nuclear Power Plant Extended to Basement

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
0	Shale, predominantly gray to greenish- gray, thin-bedded; siltstone, gray, thin-bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle(Weathered Overburden)	1460	1168	1825
1.8	Shale, predominantly gray to greenish- gray, thin-bedded; siltstone, gray, thin-bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle(Weathered Overburden)	1700	1360	2125
2.5	Shale, predominantly gray to greenish- gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle(Weathered Overburden)	600	480	750
3.8	Shale, predominantly gray to greenish-gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle(Weathered Overburden)	450	360	565
10.8	Shale, predominantly gray to greenish- gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle(Weathered Overburden)	1000	800	1250

Attachment 4 Table 1B
(continued)

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
33	Shale, predominantly gray to greenish- gray, thin-bedded; siltstone, gray, thin-bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle(Weathered Overburden)	1700	1360	2125
76	Shale, predominantly gray to greenish-gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle	2400	1920	3000
136	Shale, predominantly gray to greenish-gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Є cm - Conasauga Middle	6000	4800	7500
136-656	Shale, predominantly gray to greenish-gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone. Siltstone, greenish-gray, glauconitic, micaceous, very bioturbated, interbedded with fine-grained sandstone and shale.	Є cm - Conasauga Middle and Є pv – Pumpkin Valley Shale	6000	4800	7500

Attachment 4 Table 1B
(continued)

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
656-1000	Sandstone, reddish-brown, greenish- gray, light-brown, olive, fine-to medium-grained, thin-to thick-bedded, glauconitic, micaceous; interbedded with shale and siltstone, reddish-brown, olive greenish-gray, light-brown, thin-bedded, micaceous, bioturbated; dolomite and dolomoitic limestone may also be present; thrust fault at base, estimated exposed thickness shown.	Єr – Rome Formation	7750	6200	9285
1000-1400	Sandstone, reddish-brown, greenish-gray, light-brown, olive, fine-to medium-grained, thin-to thick-bedded, glauconitic, micaceous; interbedded with shale and siltstone, reddish-brown, olive greenish-gray, light-brown, thin-bedded, micaceous, bioturbated; dolomite and dolomoitic limestone may also be present; thrust fault at base, estimated exposed thickness shown.	Єr – Rome Formation	10,000	8000	9285
1400-2350	Sandstone, reddish-brown, greenish-gray, light-brown, olive, fine-to medium-grained, thin-to thick-bedded, glauconitic, micaceous; interbedded with shale and siltstone, reddish-brown, olive greenish-gray, light-brown, thin-bedded, micaceous, bioturbated; dolomite and dolomoitic limestone may also be present; thrust fault at base, estimated exposed thickness shown.	Єr – Rome Formation	10,000	6370	9285
2350		Kingston Fault			
2350-2700	Dolomite, light-gray with pinkish streaks and hues, fine-grained, thick-to massive-bedded, laminations; scattered quartz sand grains; limestone, light-gray, fine-grained; medium- to massive-bedded, thrombolitic, silicified gastropods; chert pods, light-gray, red, some oolitic; chert bedded, white and gastropods, and stromatolite. Base defined by chert matrix sandstone float.	Oma – Mascot Dolomite	7000	4460	9285

Attachment 4 Table 1B
(continued)

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
2700-2900	Dolomite, light-gray, fine- to coarse- grained, medium- to thick-bedded, rare oolites and scattered quartz sand grains; dolomite in the upper part is gray with pink streaks or pinkish hues; limestone, light- to medium gray, fine- grained, thick- to massive-bedded; base defined by chert, thick- to massive bedded, fine-grained, white, gastropods.	Ok – Kingsport Formation	7000	4460	9285
2900-3450	Dolomite, light-gray, tan, fine- to medium-grained, medium- to thick-bedded; chert, light-gray and white, pods, lenses, beds, oolitic, dolomoldic, fine-grained; base defined by sandstone float consisting of medium-grained quartz, and ripple laminations.	Oc – Chepultepec	7000	4460	9285
3450-4250	Dolomite, dark-gray, brownish-gray, medium- to coarse-grained (saccharoidal), medium- to massive- bedded, petroliferous odor when broken; dolomite, light-gray, fine- to coarse-grained, medium- to thick- bedded; chert, pods, lenses and beds, medium- to coarse-grained oolitic, cryptozoon, gray and white banded.	Ꞓcr – Copper Ridge Dolomite	7000	4460	9285
4250-4450	Limestone, light- to medium-gray, medium- to massive-bedded, dolomite ribbons, fine-grained, oolitic, stylolites, thrombolitic; minor shale, green, thin- bedded.	Ꞓmn – Maynardville Formation (Limestone)	9500	6050	9285
4450-6350	Shale, gray and greenish-gray, thin- bedded; siltstone, gray, thin-bedded, glauconitic and calcareous; limestone, thin-bedded, edgewise conglomerates consisting of dolomitic rip-up clasts throughout the middle and upper part of the formation. Lower part consists of interbedded siltstone, and shale, gray and greenish-gray, thin-bedded, glauconitic, micaceous, commonly bioturbated, a few marine shell fossils found.	Ꞓcl – Conasauga Group Lower Undivided	7000	4460	9285

Attachment 4 Table 1B
(continued)

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
6350		Chattanooga Fault			
6350-6450	Dolomite, light-gray, tan, fine-to medium-grained, medium- to thick-bedded; chert, light-gray and white, pods, lenses, beds, oolitic, dolomoldic, fine-grained; base defined by sandstone float consisting of medium-grained quartz, and ripple laminations.	Oc – Chepultepec Dolomite	7000	4460	9285
6450-7200	Dolomite, dark-gray, brownish-gray, medium- to coarse-grained (saccharoidal), medium- to massive- bedded, petroliferous odor when broken; dolomite, light-gray, fine- to coarse-grained, medium- to thick- bedded; chert, pods, lenses and beds, medium- to coarse-grained oolitic, cryptozoon, gray and white banded.	Ꞓcr – Copper Ridge Dolomite	7000	4460	9285
7200-7700	Limestone, light- to medium-gray, medium- to massive-bedded, dolomite ribbons, fine-grained, oolitic, stylolites, thrombolitic; minor shale, green, thin- bedded.	Ꞓmn – Maynardville Formation (limestone)	9500	6050	9285
7700-8450	Shale, predominantly greenish- and brownish-gray, thin-bedded; limestone, thin-bedded, edgewise conglomerates consisting of dolomitic rip-up clasts throughout the formation; limestone in the lower part is thick-bedded, glauconitic, oolitic. A thick- to massive bedded, light- to medium-gray, oolitic, thrombolitic, and ribboned limestone reef (Ꞓnr) occurs near the middle of the formation, which may contain irregular infillings of dark-gray, granular limestone.	Ꞓn – Nolichucky Shale	7000	4460	9285
8450-9050	Shale, predominantly gray to greenish-gray, thin-bedded; siltstone, gray, thin- bedded, glauconitic and calcareous; limestone, thin-bedded, discontinuous beds. Commonly weathers to rust colors. Overlying soil is yellowish brown and commonly contains fragments of shale and siltstone.	Ꞓcm – Conasauga Group Middle	7000	4460	9285

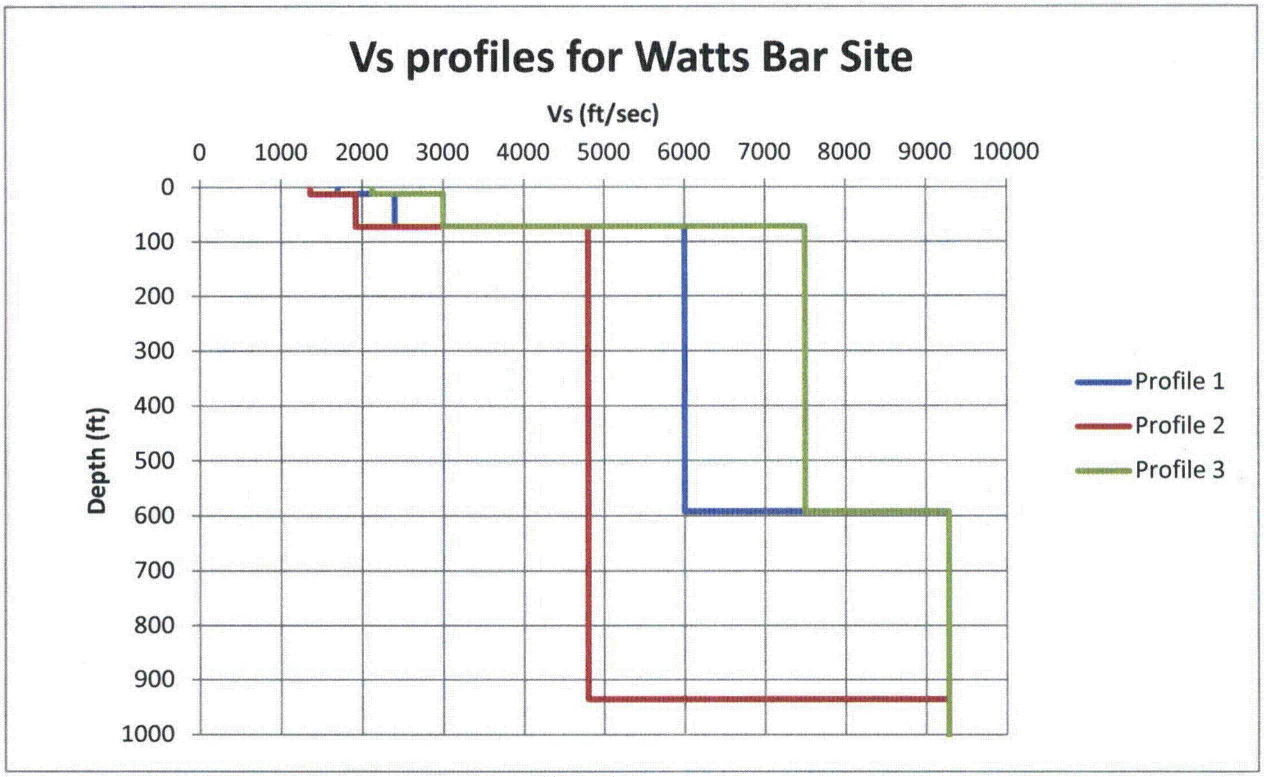
Attachment 4 Table 1B
(continued)

Depth (feet)	Soil/Rock Description*	Rock Formation	Best Estimate V_s (fps)**	Lower Range V_s (fps)***	Upper Range V_s (fps)***
9050-9450	Siltstone, greenish-gray, glauconitic, micaceous, very bioturbated, interbedded with fine-grained sandstone and shale.	Ꞓpv – Pumpkin Valley Shale	7000	4460	9285
9450-10,600	Sandstone, reddish-brown, greenish- gray, light-brown, olive, fine-to medium-grained, thin-to thick-bedded, glauconitic, micaceous; interbedded with shale and siltstone, reddish-brown, olive greenish-gray, light-brown, thin-bedded, micaceous, bioturbated; dolomite and dolomoitic limestone may also be present; thrust fault at base, estimated exposed thickness shown.	Ꞓr – Rome Formation	10,000	6370	9285
10,600		Sequatchie Valley Fault			
10,600-10,950	Sandstone, reddish-brown, greenish- gray, light-brown, olive, fine-to medium-grained, thin-to thick-bedded, glauconitic, micaceous; interbedded with shale and siltstone, reddish-brown, olive greenish-gray, light-brown, thin-bedded, micaceous, bioturbated; dolomite and dolomoitic limestone may also be present; thrust fault at base, estimated exposed thickness shown.	Ꞓr – Rome Formation	10,000	6370	9285
>10,950		Basement	12,000	7640	9285

*Note: Rock Descriptions obtained from the Geologic Map of the Decatur Quadrangle, dated 2008, Lemiszki, Kohl, and Sutton.

**Note: For depths of 0–1400 ft, these values were based on SASW testing by Dr. Ken Stokoe. For depths of 1400 ft to basement, these values were inferred based both on the previous SASW testing and collaboration with Ivan Wong from URS, who assisted Dr. Stokoe and AMEC in developing a lognormal average for the best estimate.

***Note: The lower and upper ranges were based on the best estimate, with the upper range constrained not to exceed 9285 fps. For depths of 0–1400 ft, these values were calculated using a certainty of 1.25. For depths of 1400 ft to basement, these values were calculated using a certainty of 1.57.



Attachment 4 Figure 1. Vs profiles for Watts Bar site

Attachment 4 Table 2

Layer thicknesses, depths, and Vs for 3 profiles, Watts Bar site

Profile 1			Profile 2			Profile 3		
thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)	thickness(ft)	depth (ft)	Vs(ft/s)
	0	1700		0	1360		0	2125
6.0	6.0	1700	6.0	6.0	1360	6.0	6.0	2125
6.0	12.0	1700	6.0	12.0	1360	6.0	12.0	2125
8.0	20.0	2400	8.0	20.0	1920	8.0	20.0	3000
12.0	32.0	2400	12.0	32.0	1920	12.0	32.0	3000
10.0	42.0	2400	10.0	42.0	1920	10.0	42.0	3000
8.0	50.0	2400	8.0	50.0	1920	8.0	50.0	3000
12.0	62.0	2400	12.0	62.0	1920	12.0	62.0	3000
10.0	72.0	2400	10.0	72.0	1920	10.0	72.0	3000
47.9	120.0	6000	47.9	120.0	4800	47.9	120.0	7500
56.0	176.0	6000	56.0	176.0	4800	56.0	176.0	7500
52.0	228.0	6000	52.0	228.0	4800	52.0	228.0	7500
21.9	250.0	6000	21.9	250.0	4800	21.9	250.0	7500
82.1	332.0	6000	82.1	332.0	4800	82.1	332.0	7500
52.0	384.0	6000	52.0	384.0	4800	52.0	384.0	7500
52.0	436.0	6000	52.0	436.0	4800	52.0	436.0	7500
52.0	488.0	6000	52.0	488.0	4800	52.0	488.0	7500
11.9	499.9	6000	11.9	499.9	4800	11.9	499.9	7500
92.1	592.0	6000	145.3	645.3	4800	92.1	592.0	7500
3280.8	3872.9	9285	145.3	790.6	4800	3280.8	3872.9	9285
			145.3	936.0	4800			
			3280.8	4216.8	9285			