Dynamic Earth, LLC
www.dynamic-earth.com
245 Main Street, Suite 110
Chester, NJ 07930
T. 908-879-7095

November 3, 2023
Via email: louis.digiacomo@brookfieldproperties.com

IV2 ROCKLAND LOGISTICS CENTER, LLC
C/O BROOKFIELD PROPERTIES
1 Meadowlands Plaza, Suite 200
East Rutherford, New Jersey 07073

Attention: Louis DiGiacomo

Re: SEISMIC SHEAR-WAVE VELOCITY STUDY
Proposed Rockland Logistics Center
25 Old Mill Road & Hemion Road
Section 55.22, Block 1, Lot 1
Village of Suffern, Rockland County, New York
Dynamic Earth No.: 370999004EC

Dear Mr. DiGiacomo,

Dynamic Earth, LLC (Dynamic Earth) has completed a seismic shear wave velocity survey at the above referenced site. The results of our survey are summarized below.

PROJECT DETAILS

At the time of our survey, the site was in the early phase of construction and the demolition of the former buildings within the eastern portion of the site was recently completed. The remainder of the site included stockpiles of miscellaneous debris, concrete slabs, pavements, undeveloped wooded terrain, grass covered areas, and an existing wet pond within the southern portion of the site.

Based on a September 26, 2023 *Overall Grading Plan* prepared by Dynamic Engineering Consultants, PC (Dynamic), the proposed construction will include three warehouse buildings and associated improvements; including Building #1 within the central portion of the site that will occupy a footprint area of approximately 963,100 square feet; Building #2 within the southwestern portion of the site that will occupy a footprint area of approximately 170,500 square feet; and Building #3 within the southeastern portion of the site that will occupy a footprint area of approximately 88,200 square feet. Additional site improvements include associated pavements, utilities, retaining walls, and stormwater management facilities.

SCOPE OF SERVICES

Dynamic Earth previously performed subsurface investigations at the subject site and the results were issued in a May 26, 2023 *Supplemental Geotechnical Investigation Memo Summary,* an August 27, 2021 *Stormwater Basin Area Investigation Report*, a December 9, 2022 (Updated) *Report of Preliminary Geotechnical Investigation* and a December 9, 2022 (Updated) *Stormwater Basin Area Investigation*. Due to the relatively loose/very loose subsurface conditions encountered during our previous investigations, the subsurface profile was classified as a Site Class E as defined by the International Building Code. In accordance with our recommendations within the aforementioned reports, a site specific seismic study was requested by the project team to potentially justify a higher seismic site classification.

Dynamic Earth was authorized to conduct the Seismic Shear Wave Velocity Testing in accordance with our October 10, 2023 *Contract Amendment Request* to Louis DiGiacomo of Brookfield Properties, authorized on October 10, 2023.

FIELD INVESTIGATION AND RESULTS OF SURVEY

The seismic shear wave velocity survey was performed by conducting two sets of linear arrays in a cross-hair pattern within Building #1 and one set of linear arrays in a cross-hair pattern within both Building #2 and Building #3. The locations of the testing are shown on the attached *Shear Wave Velocity Testing Location Plan*.

The results of the seismic survey indicated shear wave velocities within/near the area of Building #1 and Building #3 that were generally consistent with a seismic site classification of D. The seismic survey testing within the southwestern portion of the site within/near Building #2 generally revealed shear wave velocities consistent with a seismic site classification of C.

RESULTS OF DATA COMPARISON

Dynamic Earth performed a review of the survey data in comparison to our previous subsurface investigations for the site. The subsurface conditions during our previous investigations within the southwestern portion of the site (near Building #2) included very dense glacial deposits. Standard Penetration Test (SPT) N values within the nearby borings (B-5, B-6, B-109, B-110, and B-111) ranged between approximately five blows per foot (bpf) and 119 bpf, with a weighted average of greater than 50 bpf. As such, these relatively higher density materials are generally consistent with the higher recorded shear wave velocities within this area. The borings within the vicinity of Building #1 and Building #3 typically included relatively loose and medium dense deposits, which is generally consistent with the recorded shear wave velocities within these areas.

DEVELOPMENTAL CONSIDERATIONS

Based on the results of our comparison between the shear wave velocity testing and the subsurface conditions from our previous investigations, proposed Building #1 and Building #3 are most consistent with Site Class D; while the southwestern portion of the site (within the area of proposed Building #2) is most consistent with a Site Class C, as defined in the *American Society of Civil Engineers (ASCE) 7* and the *International Building Code*.

The recommendations included herein are contingent on Dynamic Earth remaining involved during the project in conjunction with the recommendations included in our initial reports.

Dynamic Earth appreciates the opportunity to be of service to you. Please feel free to contact us with any questions regarding this matter.

Sincerely,

DYNAMIC EARTH, LLC

Patrick J. Granitzki, P.E.
Senior Principal

Francis Van Cleve
Principal

Enclosures: *Seismic Site Classification and Optional Probabilistic/Deterministic Seismic Hazard Analysis Report*

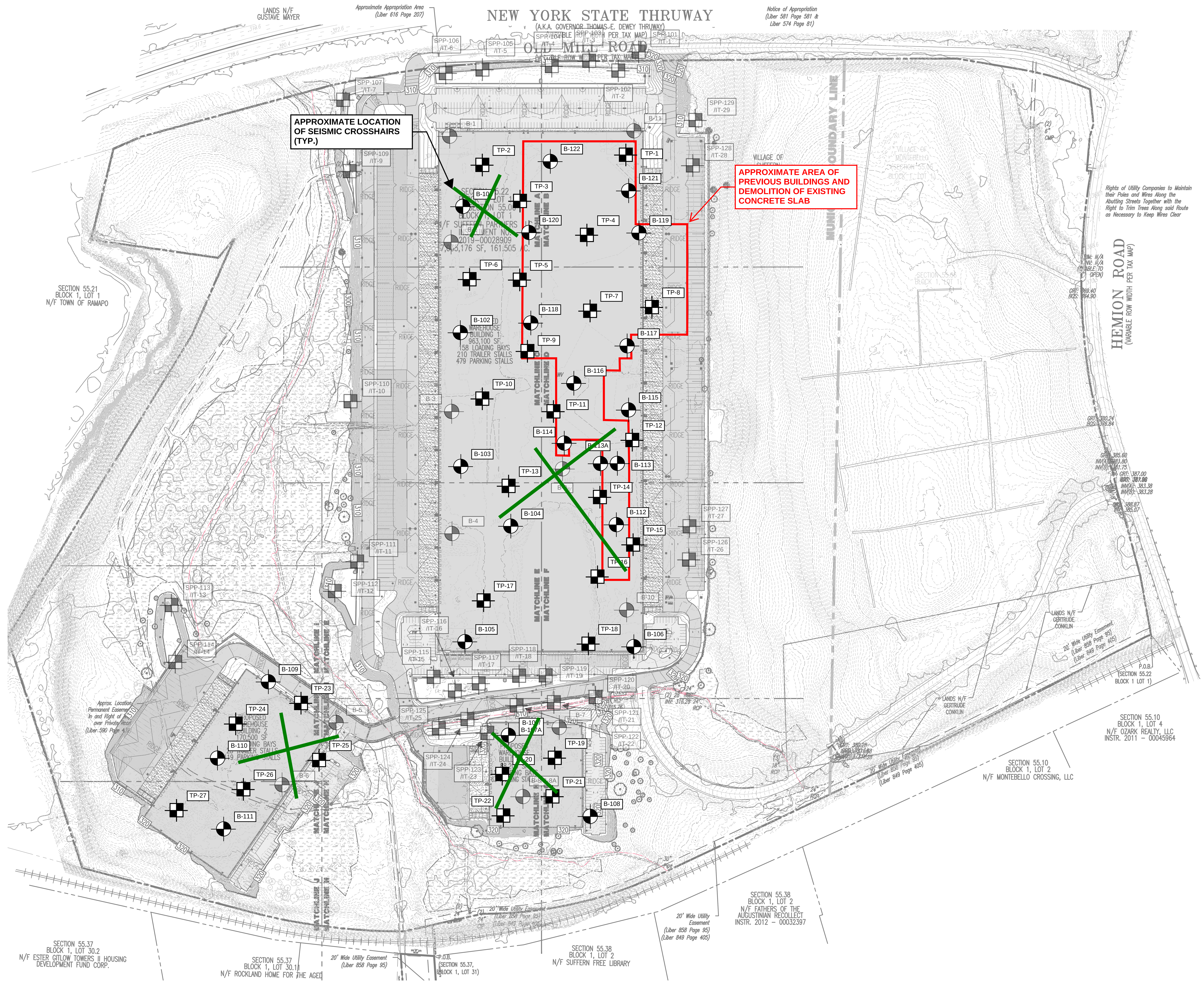
Copy: Jim Wyatt, ARCO Design Build
Patrick Devlin, ARCO Design Build
Joe Penta, ARCO Design Build

PJG/FVC O:\EARTH Projects\3709 Brookfield Properties\99-004EC Suffern NY\Reports by Dearth\Drafts\seismic letter\Brookfield Properties - Seismic Shear-Wave Velocity Characteristic.doc

Shear Wave Velocity Testing Plan

LEGEND:

B-X	APPROXIMATE LOCATION OF SOIL BORING - JULY 2022
SPP-X /IT-X	APPROXIMATE LOCATION OF SOIL PROFILE PIT AND INFILTRATION TEST - OCTOBER 2021
B-1XX	APPROXIMATE LOCATION OF SOIL BORING - MAY 2023
TP-X	APPROXIMATE LOCATION OF TEST PIT - MAY 2023



NOTES:

1. THIS PLAN IS NOT FOR CONSTRUCTION AND WAS PREPARED TO ILLUSTRATE TEST LOCATIONS ONLY AND MAY NOT REFLECT THE MOST CURRENT REVISION OF THE BASE PLAN.
2. BASE PLAN OBTAINED FROM A SEPTEMBER 01, 2022 (LAST REVISED) *OVERALL GRADING PLAN* PREPARED BY DYNAMIC ENGINEERING CONSULTANTS, P.C.

DYNAMIC • ENGINEERING • EARTH • SURVEY • TRAFFIC

REV.	DATE	COMMENTS	BY

DRAWN BY: GS | DESIGNED BY: - | CHECKED BY: - | CHECKED BY: -

PROJECT: **BROOKFIELD PROPERTIES**
PROPOSED INDUSTRIAL PARK
OLD MILL ROAD AND HEMION ROAD (CR93)
SECTION 55.22, BLOCK 1, LOT 1
VILLAGE OF SUFFERN, ROCKLAND COUNTY, NY

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DYNAMIC EARTH, LLC
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50 Park Place, Mezzanine Level
Newark, NJ 07102
T: 973.755.7200
Offices conveniently located at:
www.dynamicec.com

TITLE: **SHEAR WAVE VELOCITY TESTING PLAN**

SCALE: N.T.S. | DATE: 05/25/2023
PROJECT No: 3709-99-004EC
SHEET No: 1 OF 1 | Rev. #: 1

RETTEW

SEISMIC SITE CLASSIFICATION AND OPTIONAL PROBABILISTIC/DETERMINISTIC SEISMIC HAZARD ANALYSIS REPORT
~65-ACRE SITE, 25 OLD MILL ROAD

SUFFERN, ROCKLAND COUNTY, NEW YORK

October 24, 2023

Prepared for:

Dynamic Earth
1904 Main Street
Lake Como, NJ 07719

Prepared by:

RETTEW Field Services, Inc.
3020 Columbia Avenue
Lancaster, PA 17603

RETTEW Project No. 1136400163

RETTEW[SM]

We answer to you.

3020 Columbia Avenue, Lancaster, PA 17603 ● Phone: (800) 738-8395
E-mail: rettew@rettew.com ● Web site: rettew.com

Engineers

Environmental Consultants

Surveyors

Landscape Architects

Safety Consultants

October 24, 2023

Francis Van Cleve, PE
Dynamic Earth
1904 Main Street
Lake Como, NJ 07719

RE: Seismic Site Classification and Optional Probabilistic/Deterministic Seismic Hazard Analysis Report
~65-Acre Site, 25 Old Mill Road
Suffern, NY
RETTEW Project No. 1136400163

Dear Francis:

On September 17, 2023, RETTEW Field Services, Inc. (RETTEW) completed a seismic shear-wave field survey to determine site classification. The following report, figures, and appendices describe the methods and results of the investigation.

BACKGROUND AND SITE DESCRIPTION

The survey was performed in client-designated areas of three proposed structures over the previously developed site in Suffern, New York (see **Figure 1**). According to the NY Geological Survey (Fisher, D.W., Isachsen, Y.W., and Rickard, L.V., 1970), the site is underlain by the Upper Triassic-age Hammer Creek Formation, consisting of sedimentary clastic conglomerates. According to preliminary geotechnical investigation at the site by the client, the subsurface conditions include fill material underlain by natural glacial deposits that have loose/very loose conditions at various depths throughout the soil profile.

SITE CLASSIFICATION METHODOLOGY

To characterize the seismic shear-wave velocity profile, Refraction Microtremor (ReMi) data were collected at four locations by setting eight linear arrays (see **Figure 1**) of Mark Products 4.5-Hertz vertical geophones spaced at either constant 10-foot or 20-foot intervals (Profiles 5 and 6, at 20-foot intervals). For each line, data consisting of ambient seismic surface wave trains (generated by e.g., traffic, ocean waves, wind in the trees, etc.) were measured for twenty 30-second records at a sampling interval of 2 milliseconds. The seismic surface wave data were first analyzed using SeisImager/SW by Geometrics, Inc./Oyo Corporation. This technique makes use of the fact that much of the seismic noise at the ground surface consists of Rayleigh waves. Rayleigh waves are vertically polarized surface waves that typically contain a broad spectrum of frequency content, with lower frequencies sampling progressively greater depths. By decomposing the frequency content of a Rayleigh wave train and measuring the velocity at which each frequency component passes through the geophone array, it is possible to calculate the seismic shear-wave velocity as a function of depth beneath the geophone array.

For each seismic profile, the individual seismic records were decomposed, and their spectra averaged to develop a line-average shear-wave velocity dispersion curve that was inverted to provide a best-fit sounding or vertical profile of shear-wave velocity versus depth (**Figure 1**). The interpretive weighted average shear-wave velocities for the top 100 feet (V_{100}) in feet per second (fps) for each profile are shown on **Figure 1** and are listed below.

Profile 1 Vs_{100} = 1840.9 ft/s	Profile 5 Vs_{100} = 1082.8 ft/s
Profile 2 Vs_{100} = 1968.6 ft/s	Profile 6 Vs_{100} = 978.7 ft/s
Profile 3 Vs_{100} = 1162.3 ft/s	Profile 7 Vs_{100} = 899.2 ft/s
Profile 4 Vs_{100} = 1163.8 ft/s	Profile 8 Vs_{100} = 1132.9 ft/s

SITE CLASSIFICATION RESULTS

The V_{100} value for each array was calculated based on the weighted average formula from ASCE 7-10 Chapter 20 (Site Classification Procedure for Seismic Design, formula 20.4-1). The results indicate an average V_{100} of 1,278 fps with Profile 1 and 2 significantly higher than the other six profiles. The V_{100} values for Profile 1 and 2 are a Site Class C per the ASCE 7 and 2012 IBC with suspected bedrock around 40-50 feet below ground level, while the remaining areas are within Site Class D or close to the D/C boundary (see **Appendix A**). The V_{100} values are shown graphically compared to the International Building Code (IBC) classification on the bottom of **Figure 1**. Please note that this method of site classification is based on seismic shear-wave velocity alone, and does not take other parameters (including standard penetration number, shear strength, and engineering judgment) into consideration.

SEISMIC HAZARD ANALYSIS

PSHA ANALYSIS

A probabilistic seismic hazard analysis was performed based on the predicted ground motion data and maps developed by the US Geological Survey (USGS) Seismic Design Web Services. The results of a probabilistic study for the site, using the USGS database and application and based conservatively on the Site Class C indicated by the seismic ReMi survey (see above), are detailed in **Appendix B**. Note that a probabilistic study of this type does not include site-specific soil amplification effects. However, these results are provided since they are consistent with the site-specific results reported below.

DSHA ANALYSIS

In order to evaluate the potential effects of site-specific soil amplification, a deterministic seismic hazard analysis was performed using the modeling program DEEPSOIL v7 a “1-D wave propagation analysis program for geotechnical site response analysis of deep soil deposits” developed by the Geotechnical Group of the Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign. Input for the program included a site-specific soil profile for the site based on the boring logs provided by the client, the NY Geological Survey mapping, and other Geotechnical Survey reports. Seismic velocities for the model soil layers were assigned using the seismic analysis in **Figure 1**, with other material properties estimated from the literature.

In addition to the model soil profile, deterministic modeling requires an input earthquake ground motion to be applied at the level of bedrock. This motion is then propagated upward (numerically) through the soil profile to determine the potentially-amplified ground motion at the surface. The input ground motion should represent the maximum considered earthquake (MCE) for collapse prevention.

Since the seismicity of the greater New York City metropolitan region (encompassing the site and vicinity) includes large events that pre-date instrumentation, determination of the MCE is ambiguous. From the perspective of the NJ Geological Survey, the greater New York City vicinity "…is not located in an earthquake-prone area. It has never, in the recorded history of the state, had a severe earthquake which caused great damage."

The greater New York City area has historically experienced two damaging earthquakes. On December 18, 1737, an event damaged numerous chimneys in the city. This occurred before there was instrumentation, so an estimated magnitude of 5.2 has been assigned, and its epicenter is unknown. Another estimated 5.2 magnitude event occurred on August 10, 1884. This event caused cracked chimneys and plaster walls, and broken windows. There were scattered reports of objects thrown from shelves throughout New York City and surrounding towns in New York and New Jersey. This event was felt as far west as Toledo, Ohio and as far north as Penobscot Bay, Maine. To the south, there were reports of perceptible shaking as far as Baltimore, Maryland. The magnitude of this earthquake has also been set at 5.2.

A search of the USGS earthquake catalogue finds that the largest instrument-recorded earthquake in the region was an October 19, 1985 event centered in Greenville, NY 25 miles directly north of the site. This was widely felt in the Mid-Atlantic states, but there are no reports of damage. A 3.5 magnitude event 33 miles southwest in Marlboro NJ occurred on January 30, 1979. On September 9, 2020, another event occurred in the same location at magnitude 3.1. For this more recent event, the DYFI (did you feel it) map shows two "felt" reports (of weak shaking) within a mile of the site, but no reports of damage.

The largest recorded earthquakes in the Eastern USA are listed in the table below. The magnitude 5.8 Mineral VA earthquake of August 23, 2011 was the only one that produced (minimal) damage in Brooklyn. Others were felt in Brooklyn and may have caused hanging objects to swing, or windows to rattle, but no damage was reported.

Historical earthquakes in Boston, MA (1755) and Charleston, SC (1886) had estimated magnitudes between 6 and 7, and were felt throughout the eastern US, suggesting the possibility of shaking at the Brooklyn site from similar rare events, but the historical record is insufficient to estimate their probability. As summarized by the New York City Consortium for Earthquake Loss Mitigation (NYCEM), the local seismicity (using the Modified Mercalli Intensity or MM scale) can be characterized as follows:

- Earthquakes with intensity of about VII (considerable damage to poorly built structures) have occurred every 100 years.
- Regional seismicity indicates that Intensity VII events are likely to occur on average every 100-200 years (i.e., 20 to 40 percent probability of occurrence in 50 years).
- Larger earthquakes, with MM Intensity VIII-IX (slight to considerable damage to resistant structures) may occur (at unspecified intervals).
- Even larger magnitudes and/or higher intensities, at very low levels of probability, cannot be excluded.

Date	Epicenter	Magnitude	Effects in Brooklyn
3/1/1925	9 km WSW of Saint-Pascal, Canada	6.3	No data
3/24/1978	North Atlantic Ocean	6.1	No data
11/25/1988	33 km S of Saguenay, Canada	5.9	No data
8/23/2011	11 km SSW of Mineral, Virginia	5.8	Widely felt, some cracked plaster and glass
12/24/1940	5 km NNW of Tamworth, New Hampshire	5.6	No data
11/1/1935	13 km N of Notre-Dame-du-Lac, Canada	5.6	No data
9/5/1944	6 km S of Cornwall, Canada	5.5	Felt by many, windows rattled
3/9/1937	3 km NNW of Kettlersville, Ohio	5.4	No data
6/23/2010	29 km NNE of Val-des-Monts, Canada	5.4	Felt by several, hanging objects swung
4/20/2002	8 km NNW of Au Sable Forks, New York	5.3	Felt by several, hanging objects swung
11/9/1968	6 km WNW of Omaha, Illinois	5.3	None
12/20/1940	8 km W of Tamworth, New Hampshire	5.3	No data
6/10/1987	2 km ESE of Claremont, Illinois	5.2	None
2/10/1914	53 km W of Perth, Canada	5.2	No data
2/21/1916	3 km NNE of Royal Pines, North Carolina	5.2	No data
4/18/2008	7 km NNE of Bellmont, Illinois	5.2	None
8/9/2020	4 km SE of Sparta, North Carolina	5.1	Felt by few
10/7/1983	8 km WSW of Newcomb, New York	5.1	Felt by many, windows rattled
3/21/1904	4 km ESE of Charlotte, Maine	5.1	No data
10/18/1916	3 km NNE of Vandiver, Alabama	5.1	No data
11/4/1903	1 km ESE of Tallapoosa, Missouri	5.1	No data
5/26/1909	3 km WNW of Lockport, Illinois	5.1	No data
4/9/1917	7 km S of Fults, Illinois	5.1	No data
9/27/1909	4 km NNE of Rockville, Indiana	5.1	No data
5/17/2013	20 km NNE of Shawville, Canada	5.1	None
1/31/1986	4 km NNW of Chardon, Ohio	5.0	None
7/27/1980	2 km SW of Sharpsburg, Kentucky	5.0	None
3/2/1937	3 km E of New Knoxville, Ohio	5.0	No data

For this study, the MCE is defined (following the method of Nikolau, 2008) as ground motion with a 10% probability of exceedance in 50 years, corresponding to an approximated return period of 475 years, or more conservatively, as a 2% probability of exceedance in 50 years, with an approximate 2,475-year return period. This defines the peak motion for the MCE.

In order to apply representative ground motion time series for the MCE, this study used seven different instrumental ground motion records, scaled to approximate the 475- and 2,475-year return period MCE peak motion. Scaling was based on the probabilistic USGS hazard curve for the site using the peak ground acceleration (PGA in g) where it intersects the 475- and 2,475-year return periods (**Appendix C**). These yield PGA's of 0.0443 g and 0.1768 g, respectively.

Each of these scaled strong motion records was applied at the base of the model soil profile, and the motion propagated upwards to the ground surface (using DEEPSOILv7.0). From the resulting surficial ground motion records (time histories) and associated ground motion spectra (amplitudes), the PGA was determined, along with the spectral acceleration (SA) at periods of 0.2, 1.0, and 2.0 seconds, as well as the peak spectral acceleration at any period greater than 0.2 seconds, as listed (in g) in **Table 1** below.

1. *Table 1: Seismo-Stratigraphic Model*

Layer	Z_{top} (ft)	Z_{bottom} (ft)	T (ft)	V_s (fps)	ρ (pcf)	Damping %	Material	
1	0	0.5	0.5	750	75	1	Topsoil	dry
2	0.5	5.0	4.5	775	125	1	Fill	dry
3	5.0	10.0	5.0	745	122	1	Fill	saturated
4	10.0	20.0	10.0	890	132	1	Glacial Sand	saturated
5	20.0	40.0	20.0	800	125	1	Glacial Sand	saturated
6	40.0	60.0	20.0	1000	135	1	Glacial Sand	saturated
7	60.0	80.0	20.0	1500	136	1	Glacial Sand	saturated
8	80.0	105.0	25.0	1700	145	1	Glacial Sand	saturated
9	105.0	130.0	25.0	2800	150	1	Glacial Sand	saturated

Five of the strong motion seismic records selected as input are listed below. All of these are among the strongest recorded earthquakes in the Eastern US and were widely felt.

- Mineral (VA, 2011, M5.8)
- Miramichi (New Brunswick, 1982, M5.7)
- Mt. Carmel (Il, 2008, M5.2)
- Saguenay (Quebec, 1988, M5.9)
- Val des Bois (Quebec, 2010, M5.0)

Two additional events which were particularly damaging to structures (based on their spectral content) were also included.

- Chichi (Taiwan, 1999, M7.3)
- Kobe (Japan, 1995, M7.2)

Each of these scaled strong motion records was applied at the base of the model soil profile, and the motion propagated upwards to the ground surface (using DEEPSOILv7.0). From the resulting surficial ground motion records (time histories) and associated ground motion spectra (amplitudes), the PGA was determined, along with the spectral acceleration (SA) at periods of 0.2, 1.0, and 2.0 seconds, as well as the peak spectral acceleration at any period greater than 0.2 seconds, as listed (in g) in **Table 2** below. Example individual time histories and response spectra are included in **Appendix D**. On the example spectra, the long blue traces are the input motion (first page), while the blue plots are the amplified spectrum at the soil surface (second page)**.**

Table 2: PGA and SA Values for Representative Strong Motion Records Scaled to the MCE

	Rock PGA=0.0443 g; 10% probability of exceedance in 50 years or 475-year return					Rock PGA=0.1768 g; 2% probability of exceedance in 50 years or 2475-year return				
Time History	**PGA**	**SA at 0.2s**	**SA at 1.0s**	**SA at 2.0s**	**Peak SA at >0.2s**	**PGA**	**SA at 0.2s**	**SA at 1.0s**	**SA at 2.0s**	**Peak SA at >0.2s**
Chichi	0.008	0.125	0.066	0.056	0.292	0.032	0.499	0.265	0.224	1.166
Kobe	0.088	0.129	0.099	0.025	0.445	0.352	0.513	0.393	0.098	1.776
Mineral	0.058	0.227	0.039	0.018	0.383	0.232	0.904	0.156	0.073	1.530
Miramichi	0.030	0.044	0.001	0.000	0.035	0.121	0.176	0.005	0.001	0.140
Mt. Carmel	1.4E-07	4.3E-05	2.8E-05	7.4E-06	7.6E-05	0.002	0.717	0.476	0.123	1.280
Saguenay	0.018	0.087	0.104	0.021	0.318	0.071	0.349	0.415	0.085	1.269
Val des Bois	0.000	0.058	0.169	0.038	0.175	0.000	0.231	0.675	0.151	0.699
Median	0.018	0.087	0.066	0.021	0.292	0.071	0.499	0.393	0.098	1.269
σ	0.033	0.073	0.061	0.020	0.171	0.132	0.261	0.220	0.069	0.545
Median + 1σ	0.051	0.161	0.127	0.041	0.463	0.203	0.759	0.613	0.167	1.815
Median + 2σ	0.084	0.234	0.188	0.061	0.634	0.335	1.020	0.833	0.237	2.360
Median x 1.5	0.027	0.131	0.100	0.032	0.438	0.107	0.748	0.590	0.147	1.904
Median x 2.0				0.043					0.196	
90% of Median					0.263					1.142

Appendix E provides an example of how the bedrock motion is amplified by the soil profile. The soil profile is depicted in color on the left. The peak displacements as a function of depth are the red envelope on the right. The blue curve shows the instantaneous displacement as a function of depth at the specified times during the earthquake event.

The use of multiple input earthquake time histories allowed calculation of the spectral parameters listed (in g, see **Table 2** above). Standard deviations across the multiple input motions provide a measure of the variability that may be expected for differing possible earthquake locations and/or focal mechanism. In addition, the value for 90% of peak spectral acceleration at period greater than 0.2 seconds, and the value for 2x the spectral acceleration at period 2.0 seconds are listed for determination of design accelerations.

LIMITATIONS

The geophysical survey described above was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology. RETTEW does not accept responsibility for survey limitations due to inherent technological limitations or unforeseen site-specific conditions. However, we make every effort to identify and notify the client of such limitations or conditions.

We have enjoyed and appreciated this opportunity to have worked with you. If you have any questions, please do not hesitate to contact the undersigned.

Sincerely,

Charles H. Rhine, PG
Geophysics/Subsurface Utility Engineering Team Lead
chuck.rhine@rettew.com

Technical Review By:

Felicia Kegel Bechtel, MSc, PG
Senior Geophysical Advisor and Special Projects
felicia.bechtel@rettew.com

Enclosures
Figure 1: Refraction Microtremor (ReMi) Results
Appendix A: IBC Site Classification Table
Appendix B: Probabilistic Site Hazard Analysis
Appendix C: Probabilistic Site Hazard Curves
Appendix D: Ground Surface Acceleration Time Histories and Response Spectra
Appendix E: Soil Amplification Animation Screenshots

References
Fisher, D.W., Isachsen, Y.W., and Rickard, L.V., 1970, Geologic Map of New York State, consisting of 5 sheets: Niagara, Finger Lakes, Hudson-Mohawk, Adirondack, and Lower Hudson, New York State Museum and Science Service, Map and Chart Series No. 15, scale 1:250,000.

Nikolau, S. (2008) Site-Specific Seismic Studies for Optimal Structural Design, Structure Magazine, February, 2008.

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Staley, A. W., Bell, S. C., Andreasen, D. C., & Bolton, D. W. (2004) Hydrogeologic Data for the Coastal Plain Sediments Northwest of Ft. Meade, Maryland, Administrative Report 09-02-04, Maryland Geological Survey.

USGS Earthquake Map (https://earthquake.usgs.gov/earthquakes/map).

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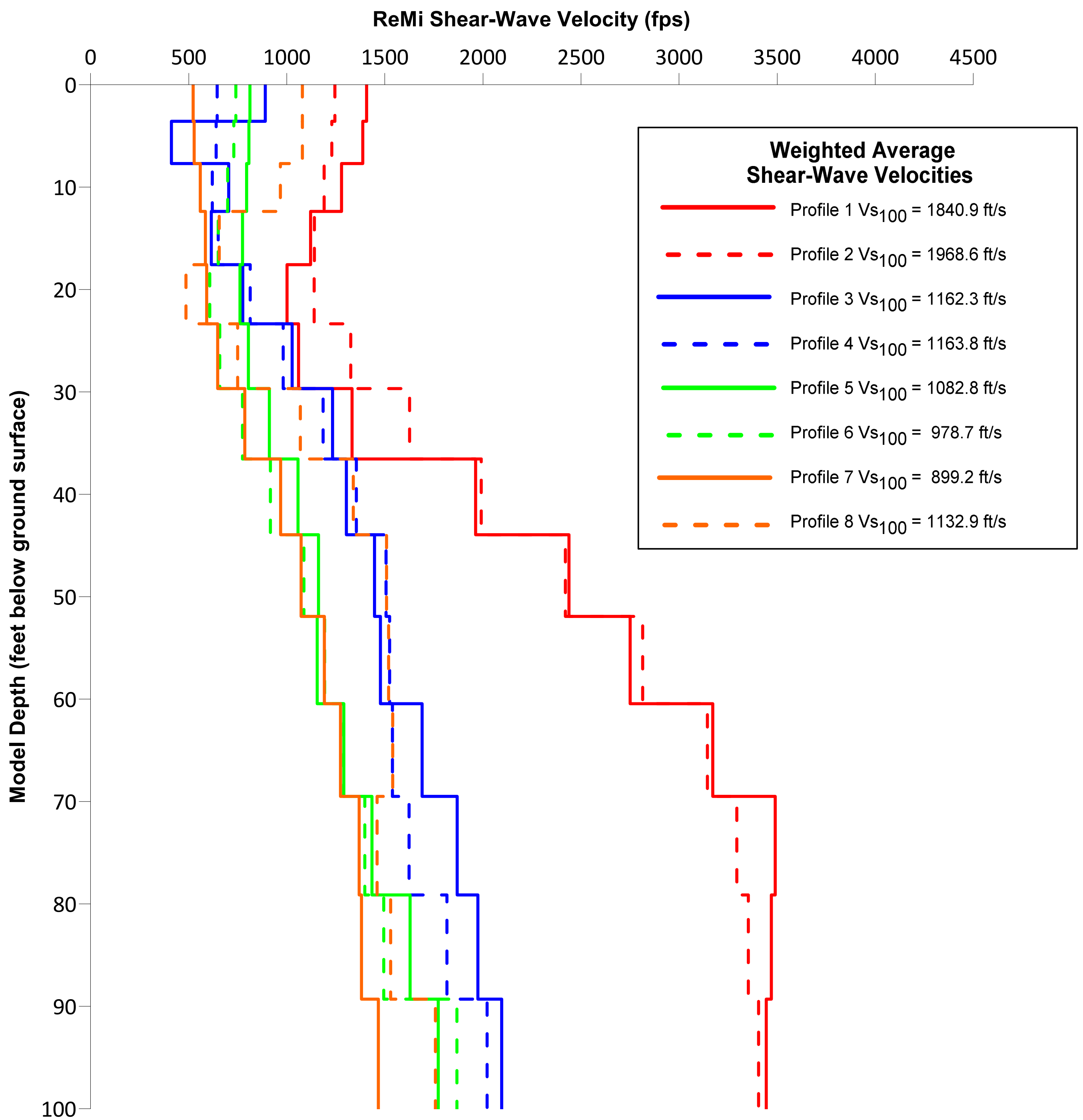
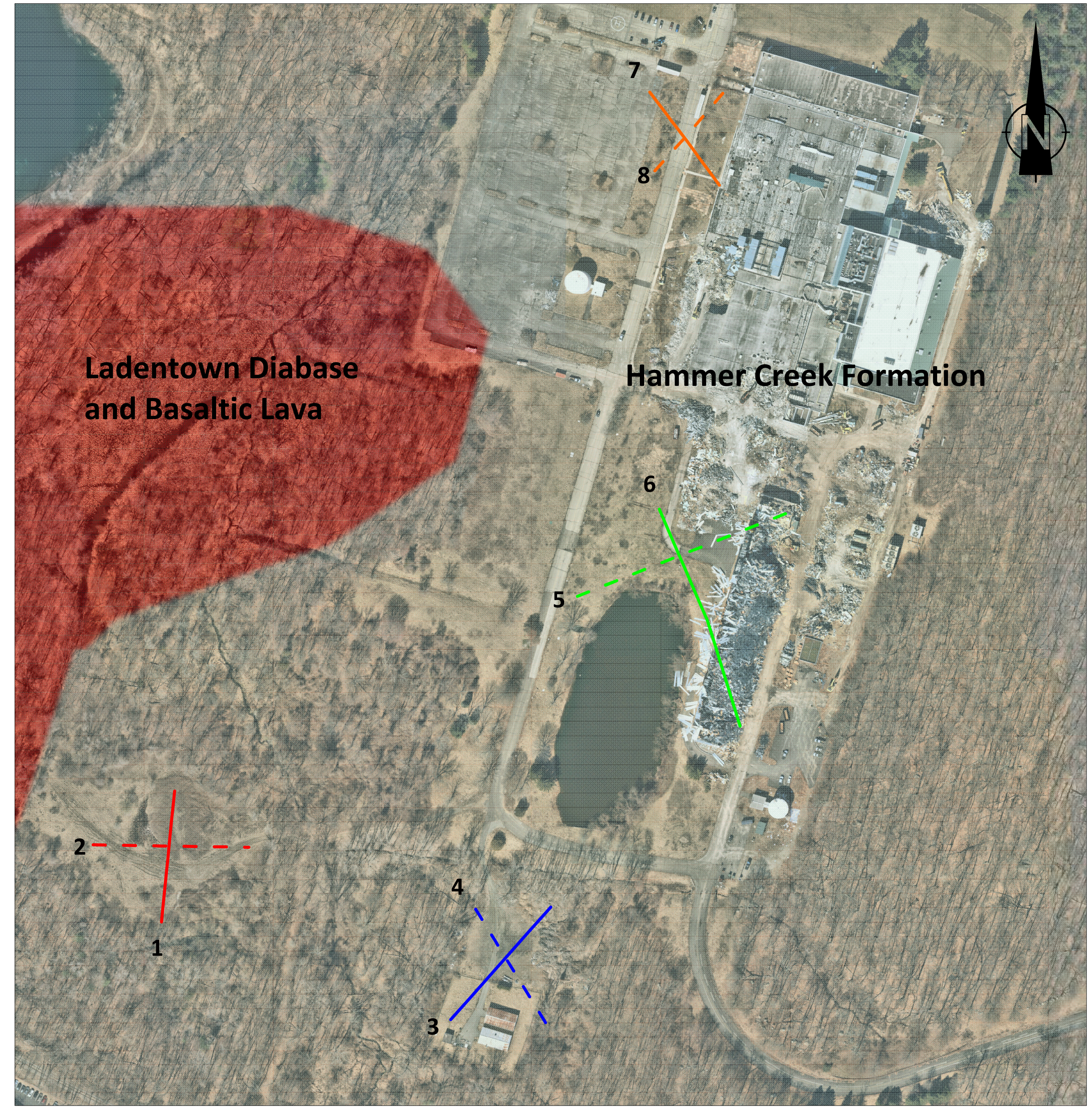
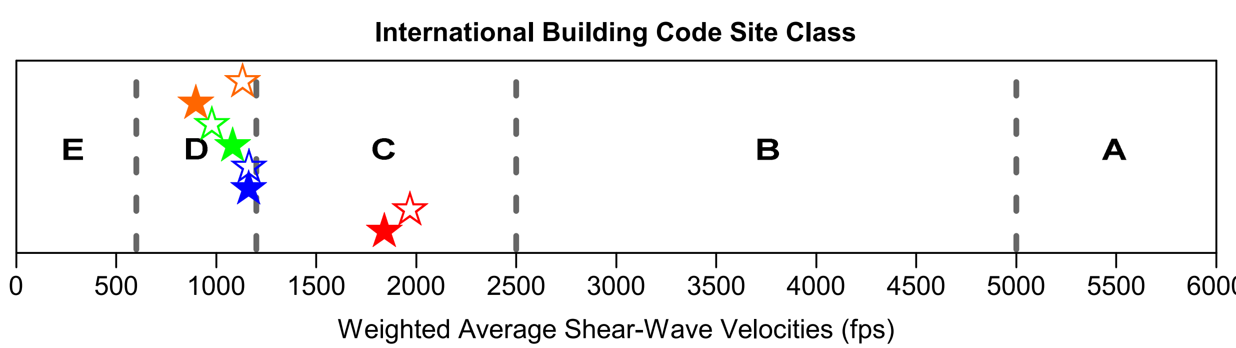
ENCLOSURES







Notes:

Basemap from USGS NAIP Plus.

Seismic data from Geometrics Geode, 4.5-Hz geophones at 10-foot spacing (Profiles 5 and 6 at 20-foot spacing).

Weighted average shear-wave velocities (Vs) from SeisImager/SW by Geometrics, Inc./OYO Corporation.

SURVEY DATE:	10/17/2023
RETTEW No.:	1136400163
REVIEWED BY:	FKB
DRAWN BY:	CHR
REVISION DATE:	10/24/2023
SCALE:	1" = 160'
FIGURE NO.	1 of 1

RETTEW[SM]

RETTEW Field Services, Inc.
3020 Columbia Avenue, Lancaster, PA 17603
Phone 1-800-738-8395

Figure 1: Refraction Microtremor Survey Results

Seismic Site Classification
25 Old Mill Road
Suffern, NY

Rockland County, NY

VILLAGE OF SUFFERN

APPENDIX A

IBC / ASCE 7 Site Classification Table

ASCE 7
SITE CLASS DEFINITIONS

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100 FEET, AS PER SECTION 1613.5.5		
		Soil shear-wave velocity, $\bar{v}_s$, (fps)	**Standard penetration resistance, $\bar{N}$ *or Nc***	**Undrained shear strength, $\bar{s}_u$, (psf)**
A	Hard rock	$\bar{v}_s > 5{,}000$	Not applicable	Not applicable
B	Rock	$2{,}500 < \bar{v}_s \leq 5{,}000$	Not applicable	Not applicable
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_s \leq 2{,}500$	$\bar{N} > 50$	$\bar{s}_u > 2{,}000$
D	Stiff soil	$600 \leq \bar{v}_s \leq 1{,}200$	15 to 20	1,000 to 2,000 psf
E	Soft clay soil	$\bar{v}_s < 600$	< 15	<1,000 psf
E	Soft clay soil	Any profile with more than 10 feet of soil having the following characteristics: • Plasticity index $PI > 20$; • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf.		
F	Soil requires site response analysis	Liquefiable soils, peat, high plasticity clay		

Reference: American Society of Civil Engineers and Structural Engineering Institute, *Minimum Design Loads for Buildings and Other Structures*, Including Supplement No. 1 (ASCE 7)

Transcribed by RETTEW

APPENDIX B

Probabilistic Site Hazard Analysis

ATC Hazards by Location

Search Information

Coordinates: 41.11863595557759, -74.13518056085205

Elevation: 316 ft

Timestamp: 2023-10-20T12:37:18.388Z

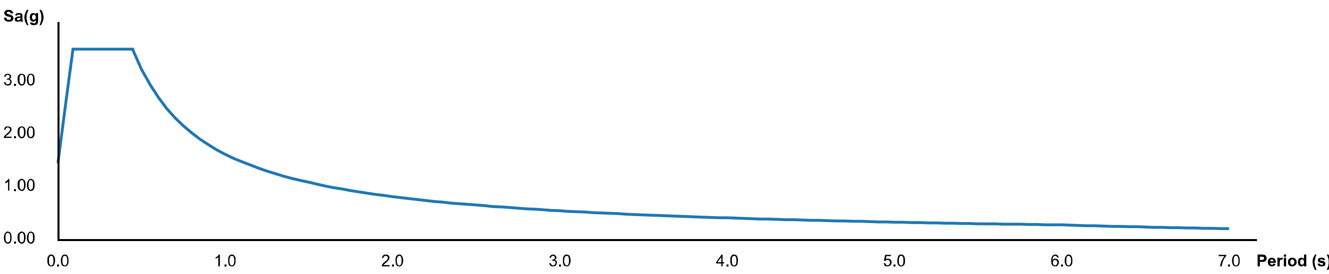
Hazard Type: Seismic

Reference Document: ASCE41-17

Site Class: D

Custom Probability: 0

Horizontal Response Spectrum - Hazard Level 0



Custom Hazard Level 0

Name	Value	Description
CP	null	Custom Probability
S_S	3.608	MCE_R ground motion (period=0.2s)
F_a	1	Site amplification factor at 0.2s
S_{XS}	3.608	Site modified spectral response (0.2s)
S_1	0.949	MCE_R ground motion (period=1.0s)
F_v	1.7	Site amplification factor at 1.0s
S_{X1}	1.613	Site modified spectral response (1.0s)

T_L Data

Name	Value	Description
T_L	6	Long-period transition period (s)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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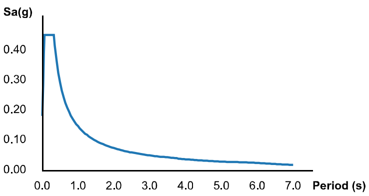
ATC Hazards by Location

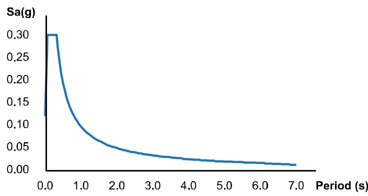
Search Information

Coordinates:	41.11863595557759, -74.13518056085205
Elevation:	316 ft
Timestamp:	2023-10-20T12:40:36.263Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	III
Site Class:	D

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.287	MCE_R ground motion (period=0.2s)
S_1	0.061	MCE_R ground motion (period=1.0s)
S_{MS}	0.451	Site-modified spectral acceleration value
S_{M1}	0.146	Site-modified spectral acceleration value
S_{DS}	0.301	Numeric seismic design value at 0.2s SA
S_{D1}	0.097	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	B	Seismic design category
F_a	1.57	Site amplification factor at 0.2s
F_v	2.4	Site amplification factor at 1.0s
CR_S	0.937	Coefficient of risk (0.2s)
CR_1	0.941	Coefficient of risk (1.0s)
PGA	0.177	MCE_G peak ground acceleration
F_{PGA}	1.446	Site amplification factor at PGA
PGA_M	0.256	Site modified peak ground acceleration
T_L	6	Long-period transition period (s)
SsRT	0.287	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.307	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.061	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.064	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

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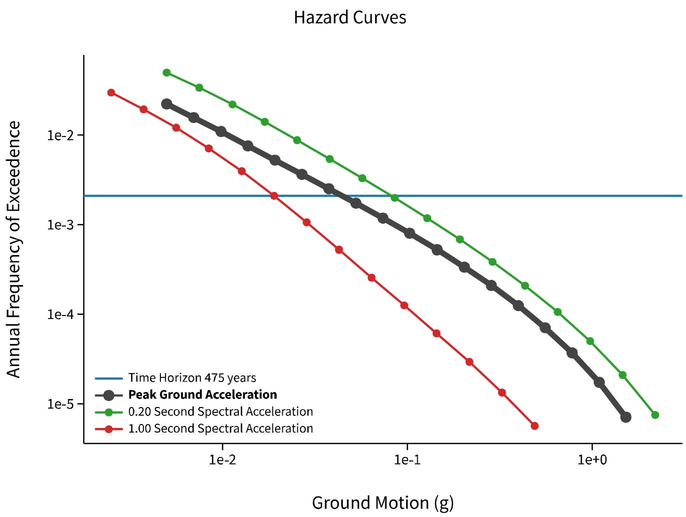
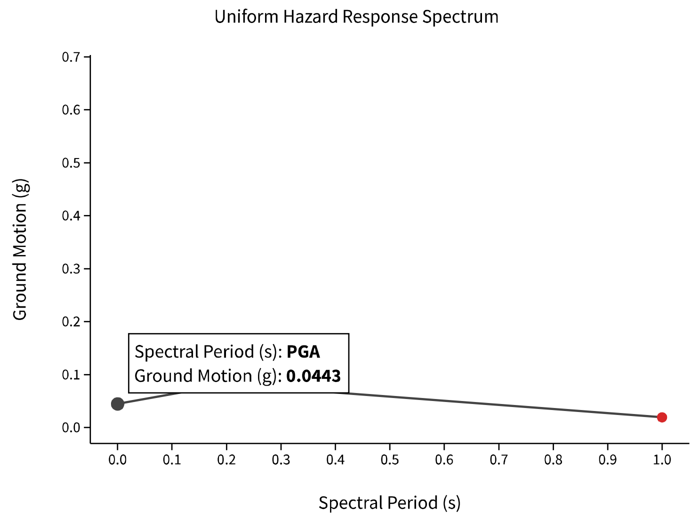
APPENDIX C

Probabilistic Site Hazard Curves

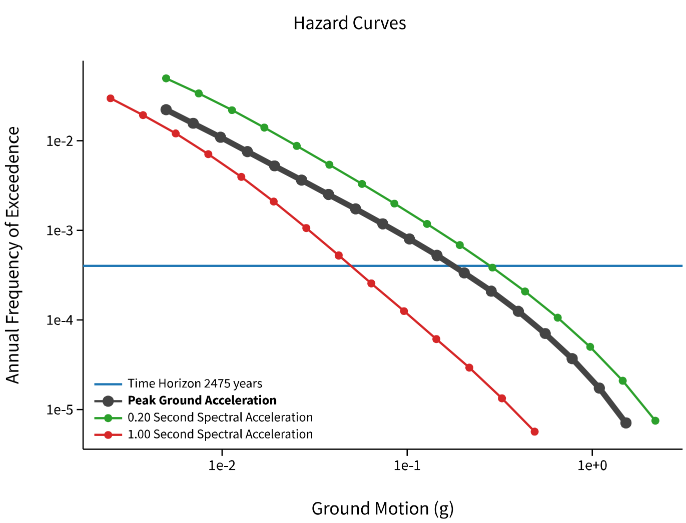
Transcribed by RETTEW

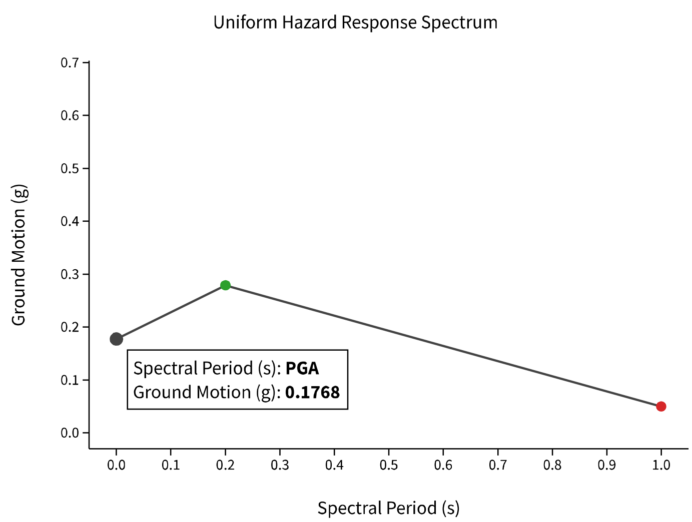
475-Year Return Period





2,475-Year Return Period





APPENDIX D

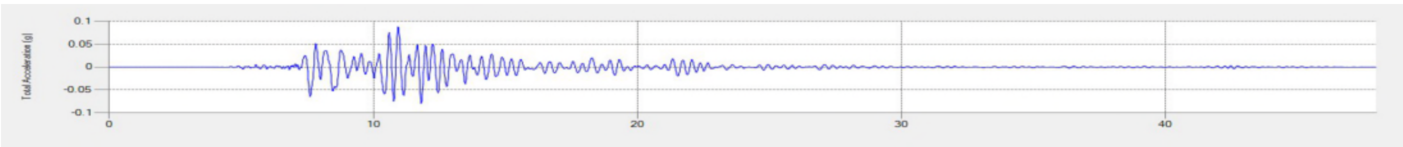
Ground Surface Acceleration Time Histories and Response Spectra

Acceleration vs. Time

ChiChi 500-year Return

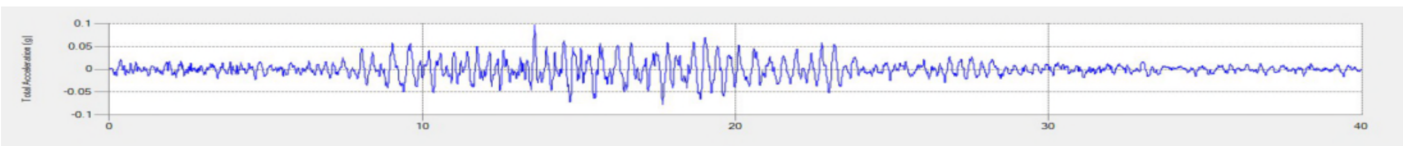
Acceleration vs. Time

Kobe 500-year Return



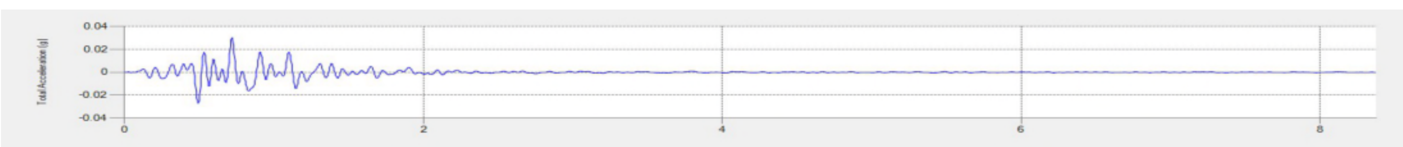
Acceleration vs. Time

Mineral Springs 500-year Return



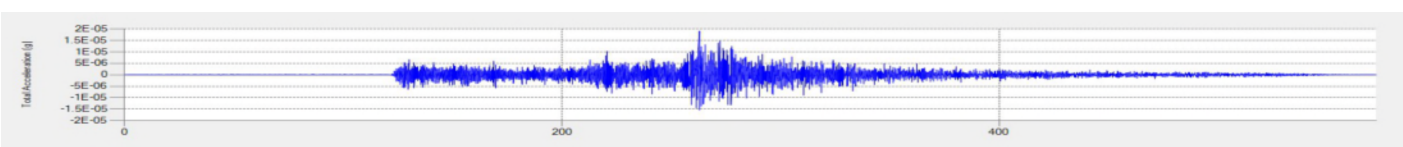
Acceleration vs. Time

Miramichi 500-year Return



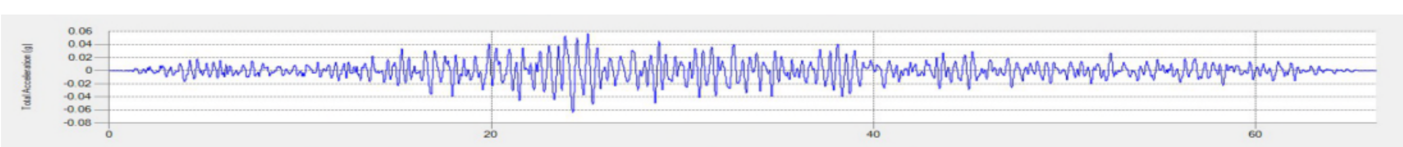
Acceleration vs. Time

Mt. Carmel 500-year Return



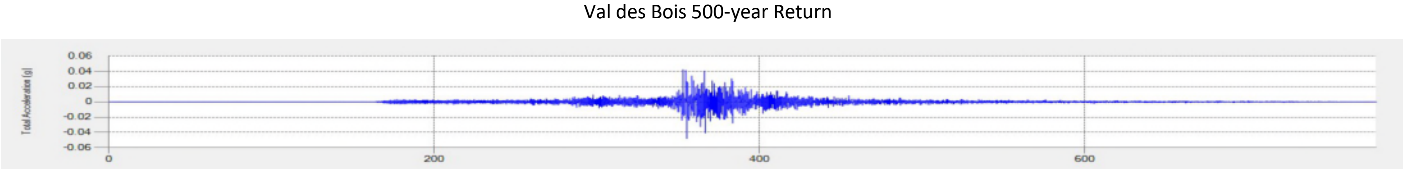
Acceleration vs. Time

Saguenay 500-year Return

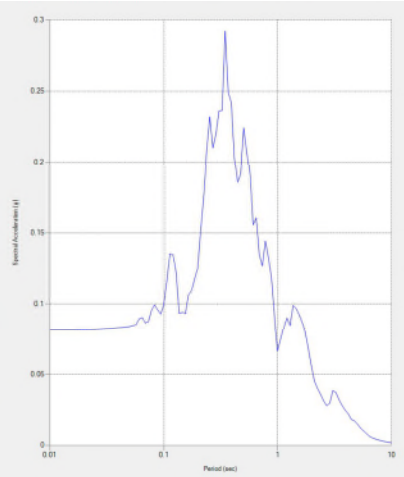


Acceleration vs. Time

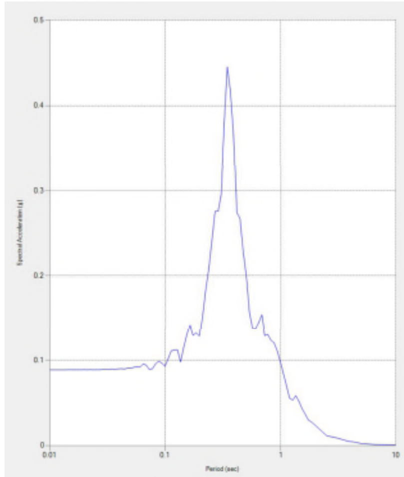
Val des Bois 500-year Return



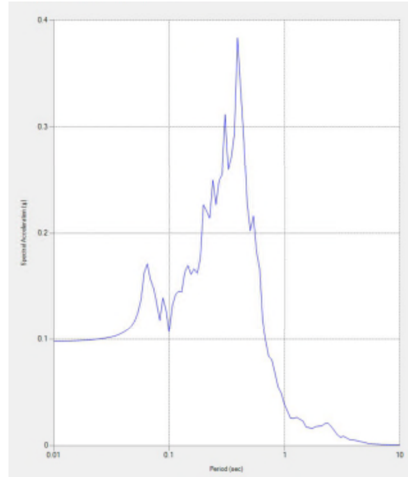
Response Spectra vs. Period
ChiChi 500-year Return



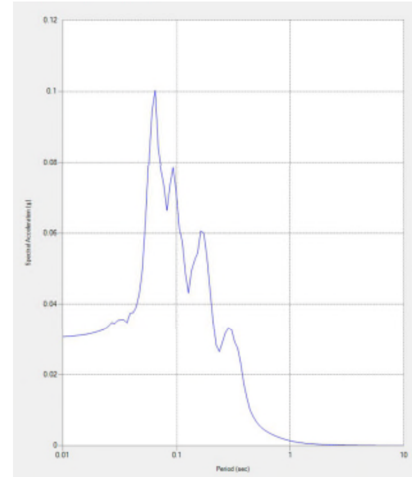
Response Spectra vs. Period
Kobe 500-year Return



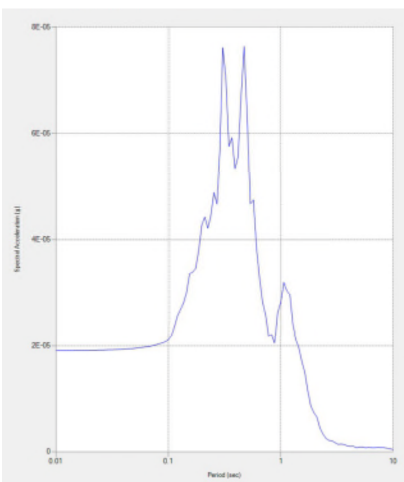
Response Spectra vs. Period
Mineral Springs 500-year Return



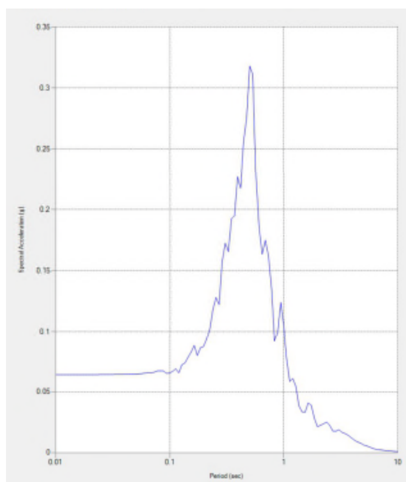
Response Spectra vs. Period
Miramichi 500-year Return



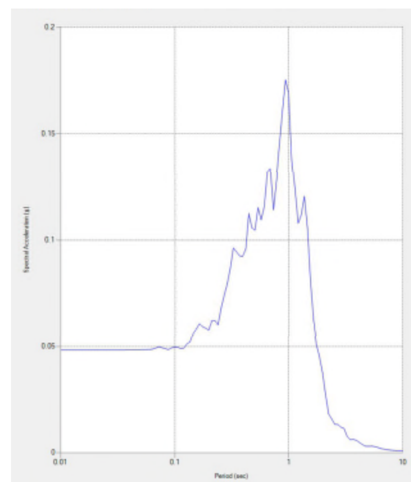
Response Spectra vs. Period
Mt. Carmel 500-year Return



Response Spectra vs. Period
Seguenay 500-year Return



Response Spectra vs. Period
Val des Bois 500-year Return



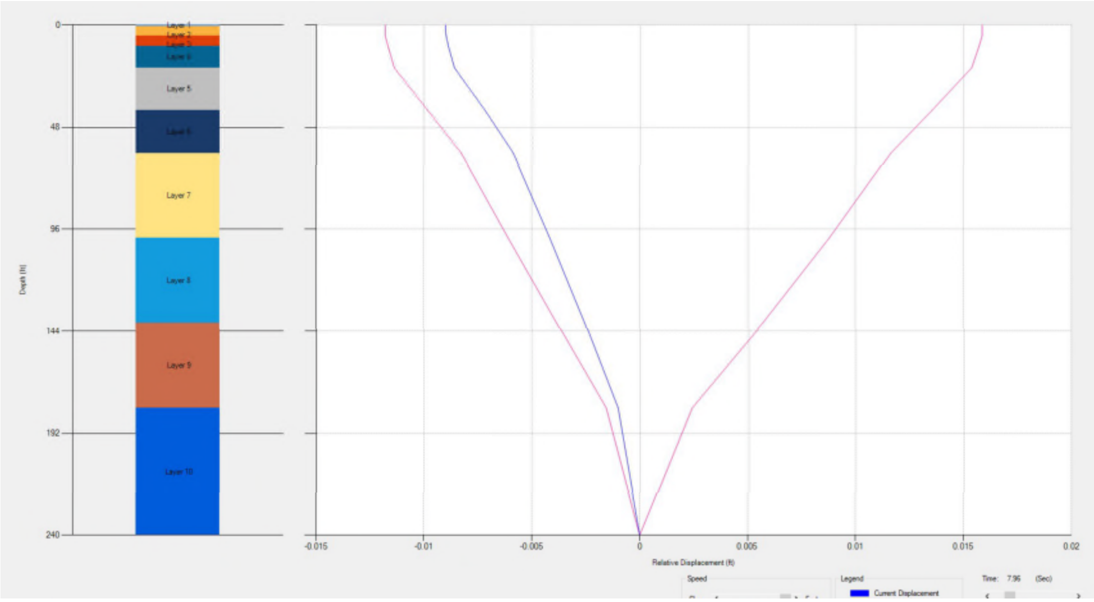
APPENDIX E

Soil Amplification Animation Screenshots

RETTEW

Column Displacement

Kobe 500-year return



Input Profile