February 4, 2019 Project No. 18106596

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ADDENDUM NO. 1 – GEOTECHNICAL INVESTIGATION
PROPOSED SITE REDEVELOPMENT
ELMVALE MALL PHASE 1
OTTAWA, ONTARIO

Dear Mr. Calvé,

This letter serves as an addendum to, and provides additional information and clarifications to, Golder Associates Ltd.'s (Golder's) geotechnical report numbered 18106596-1000, titled "*Geotechnical Investigation, Proposed Site Redevelopment, Elmvale Mall Phase 1, Ottawa, Ontario*", dated November 2018. In this regard, this letter should be read in conjunction with the contents of the original geotechnical report including the "Important Information and Limitations" document included as part of that report.

This letter provides additional geotechnical recommendations to provide input to the Triton S-29 system and to provide the results of the site-specific ground response analysis carried out for this site.

1.0 TRITON S-29 STORMWATER MANAGEMENT SYSTEM

It is understood that a Triton S-29 stormwater management system has been proposed at the site, and it will be in close proximity to the proposed structure, which may result in water being drained preferentially to the foundation wall drainage system and could potentially overwhelm the sump and pumps.

It is recommended that an impermeable cut-off or seepage barrier be constructed adjacent to the system between the Triton S-29 system and the proposed structure. The seepage barrier should extend 1.5 metres past either side of the Triton S-29 system and should extend 1.5 metres below the system invert. If the native subgrade material below the Triton S-29 system is clay, then the seepage barrier need not extend below the system invert.

2.0 SITE-SPECIFIC GROUND RESPONSE ANALYSIS

During the initial design stages of the project, portions of the site soils were considered to be potentially liquefiable during the design earthquake event, and a site-specific ground response analysis was carried out to satisfy the requirements of Site Class F outlined in the 2010 National Building Code of Canada (NBCC).

A site-specific seismic assessment was carried out to model the dynamic ground response at the site to develop a site-specific design spectrum under the 2,475 return period earthquake. Further details on the development of the spectrum-compatible input acceleration time histories, and the one-dimensional ground response analyses are included in the following sections.

2.1 Spectrum-Compatible Time Histories

The CHBDC describes two approaches to scaling input time histories to match a target spectrum: linear scaling and spectral matching. Linear scaling involves simply scaling the ordinates of the record to achieve the best fit to the target response spectrum over the period range of interest. Linear scaling provides input time histories that are more representative of the original records of ground shaking (i.e. less modification), but can be difficult to match the target spectrum over a large period range. Spectral matching involves changing the frequency and phase contents of the record to match the target spectrum. Spectral matching allows for development of input records that provide a closer match to the target spectrum over a broad range of periods but involves more modification of the original records since no real earthquake spectrum will match the entire target spectrum.

The period range of interest for selection and matching of time histories to the target spectra was taken as 0.2 to 2.0 seconds, based on the anticipated range of the fundamental period of the proposed structure.

The target spectrum used to scale the input time histories was developed using the reference Site Class C peak seismic hazard values based on the 4th generation seismic hazard maps published by the GSC and modified to the site-specific seismic site classification of Site Class A, representative of the bedrock conditions in accordance with the 2010 NBCC.

Target Seismic Hazard Values for Ground Motion Scaling for Site Class A (bedrock)

Seismic Hazard Values	2% Exceedance in 50 years (2,475 return period)
PGA (g)	0.24
Sa (0.2) (g)	0.48
Sa (0.5) (g)	0.16
Sa (1.0) (g)	0.07
Sa (2.0) (g)	0.02

Both linearly-scaled and spectrally matched time histories were used in the site-specific ground response analysis to develop the horizontal ground motions. Although only seven time histories are strictly required by the 2010 NBCC, 12 time histories were selected for this analysis. As part of site-specific ground response analyses previously carried out at a site with a similar seismic hazard, records from five earthquakes retrieved from the Pacific Earthquake Engineering Research (PEER) Center NGA-West2 database were spectrally matched to a target spectrum for Site Class A ground motions similar to that at the Elmvale Mall site. Horizontal pairs were considered for three of the five earthquakes.

An additional four time histories were selected: two representative seed time histories that matched the primary contributors were selected, and two simulated time histories were selected from the Engineering Seismology Toolbox (EST) database, These earthquakes were linearly scaled to achieve the best fit to the Site Class A target response spectrum within the period range of interest.

A summary of the earthquake records used is provided in the table below. Plots of the Site Class A scaled spectral accelerations of the input time histories are shown on Figure 1 along with the target Site Class A spectrum.

Summary of Input Time History Earthquake Events

Database	Event Name	Event Year	Station / Suite Name	Mag.	Dist. (km)	Scaling Method
PEER	San Fernando	1971	Lake Hughes #4 (H1)	6.6	19.5	Spectral Matching
PEER	San Fernando	1971	Lake Hughes #4 (H2)	6.6	19.5	Spectral Matching
PEER	N. Palm Springs	1986	Winchester Bergman (H1)	6.1	48.9	Spectral Matching
PEER	Coyote Lake	1979	Gilroy Array #1 (H1)	5.7	10.2	Spectral Matching
PEER	Northridge	1994	LA - Wonderland Ave (H1)	6.7	15.1	Spectral Matching
PEER	Northridge	1994	LA – Wonderland Ave (H2)	6.7	15.1	Spectral Matching
PEER	Nahanni	1985	Site 3 (H1)	6.8	4.9	Spectral Matching
PEER	Nahanni	1985	Site 3 (H2)	6.8	4.9	Spectral Matching
PEER	Hector Mine	1999	Twenty-nine Palms	7.1	42	Linear Scaling
PEER	Norcia Italy	1979	Cascia	5.9	1	Linear Scaling
EST	Motion #40	-	East7a1 Suite	7.0	26	Linear Scaling
EST	Motion #26	-	East7a2 Suite	7.0	70	Linear Scaling

2.2 One-Dimensional Ground Response Analyses

One-dimensional ground response analyses were undertaken to assess the ground response at the site.
The ground response analyses were carried out based on the subsurface stratigraphy and using the 2,475-year input ground motions described above.

Based on the results of the VSP Testing and boreholes, representative index properties and shear wave velocity variations of overburden soil and rock encountered were developed and are summarized in the table below. Two profiles were considered in the analysis to consider the response of the variable in bedrock elevation across the site. The first profile considers bedrock at 16 metres below the existing ground surface, and the second profile considers bedrock at 24 metres below the existing ground surface.

Summary of Representative Stratigraphy and Material Properties

Soil Unit	Depth Below Ground Surface (m)	γ (kN/m^3)	V_s (m/s)
Fill – Sand	0 – 1	18	260
Silty Clay – Weathered Crust	1 – 4	17	180 – 220
Silty Clay	4 – 9	16	175 – 315
Glacial Till	9 – 16 (Profile 1) 9 – 24 (Profile 2)	22	405 – 630

Where required for analysis, the small-strain shear modulus (G_{max}) for the site soils encountered within the depth of investigation were estimated using the site-specific shear wave velocity (V_s) measurements obtained from the results of the VSP testing. The values of G_{max} and V_s are related through the following expression:

$$G_{max} = \rho\,(V_s)^2 \text{, where } \rho = \text{material density.}$$

2.2.1 Shake Analysis Models

The one-dimensional soil columns and soil parameters described above were used for the ground response analyses. For all soil columns, the input motions established for the site were applied at the top of the bedrock as outcropping motions to account for the overburden effects. All ground response analyses were carried out using the software Shake2000 (Version 99.99.93, released June 2015, part of the Professional Suite of ground response software by GeoMotions, LLC).

The modulus reduction and damping verses shear strain curves used for the main soil strata are as follows:

- Granular Fill: Seed and Idriss (1970) average curves for shear modulus and damping;
- Silty Clay: Vucetic and Dobry (1991) curves for Soil with PI = 30, OCR = 1-15 for shear modulus and Soil with PI = 30, OCR = 1-8 for damping;
- Glacial Till: Vucetic and Dobry (1991) curves for Soil with PI = 15, OCR = 1-15 for shear modulus and Soil with PI = 15, OCR = 1-8 for damping; and,
- Bedrock: Schnabel (1973) curves for shear modulus and damping.

2.2.2 Analysis Results

As noted in the previous section, the ground response analyses were carried out to obtain the acceleration time histories at the ground surface for the 2,475-year ground motions. The spectral accelerations of the output time histories at the foundation level of about 71 metres Elevation (i.e. about 7 metres below the existing ground surface) are shown on Figures 2 and 3 for the profiles considering bedrock at 16 metres below ground surface and 24 metres below ground surface, respectively. For comparison, the output time histories for the design earthquake event are plotted relative to the Site Class C design response spectrum.

The average ground response from all 12 output motions at the foundation level of about 71 m Elevation for both profiles are shown on Figure 4 along with the Site Class C hazard spectrum. Figure 4 also shows the proposed design spectrum at the foundation level selected for this structure.

3.0 CLOSURE

We trust that this report is sufficient for your present requirements. If you have any questions concerning this report, please feel free to contact the undersigned.

Yours truly,

Golder Associates Ltd.

Sarah Ghadbane, P.Eng.
Geotechnical Engineer

Nicolas LeBlanc, P.Eng.
Senior Geotechnical Engineer

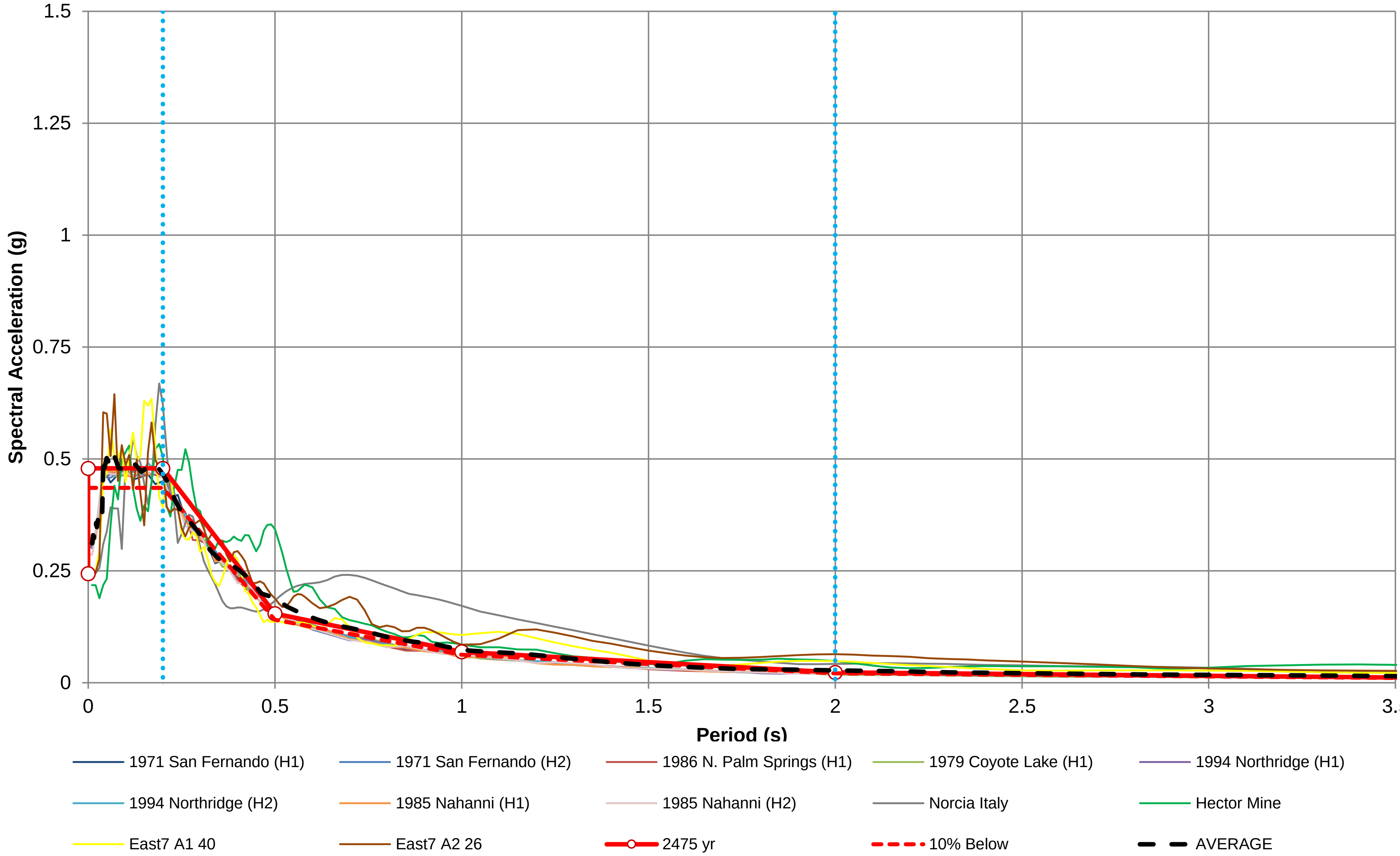
SG/NRL/mvrd
https://golderassociates.sharepoint.com/sites/30877g/deliverables/geotechnical report/addendum 1/18106596-001-l-rev0-addendum no 1-feb2019.docx

Attachments: Figure 1 – Site Class A Scaled Input Response Spectra

Figure 2 – Shake 2000 Output: Foundation Elevation (~71 masl) Response Spectra – Shallow Bedrock Conditions (Profile 1)

Figure 3 – Shake 2000 Output: Foundation Elevation (~71 masl) Response Spectra – Deep Bedrock Conditions (Profile 2)

Figure 4 – Recommended Site-Specific Design Spectra at Foundation Elevation (~71 masl)



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Proposed Site Redevelopment
Elmvale Mall Phase 1
Ottawa, Ontario

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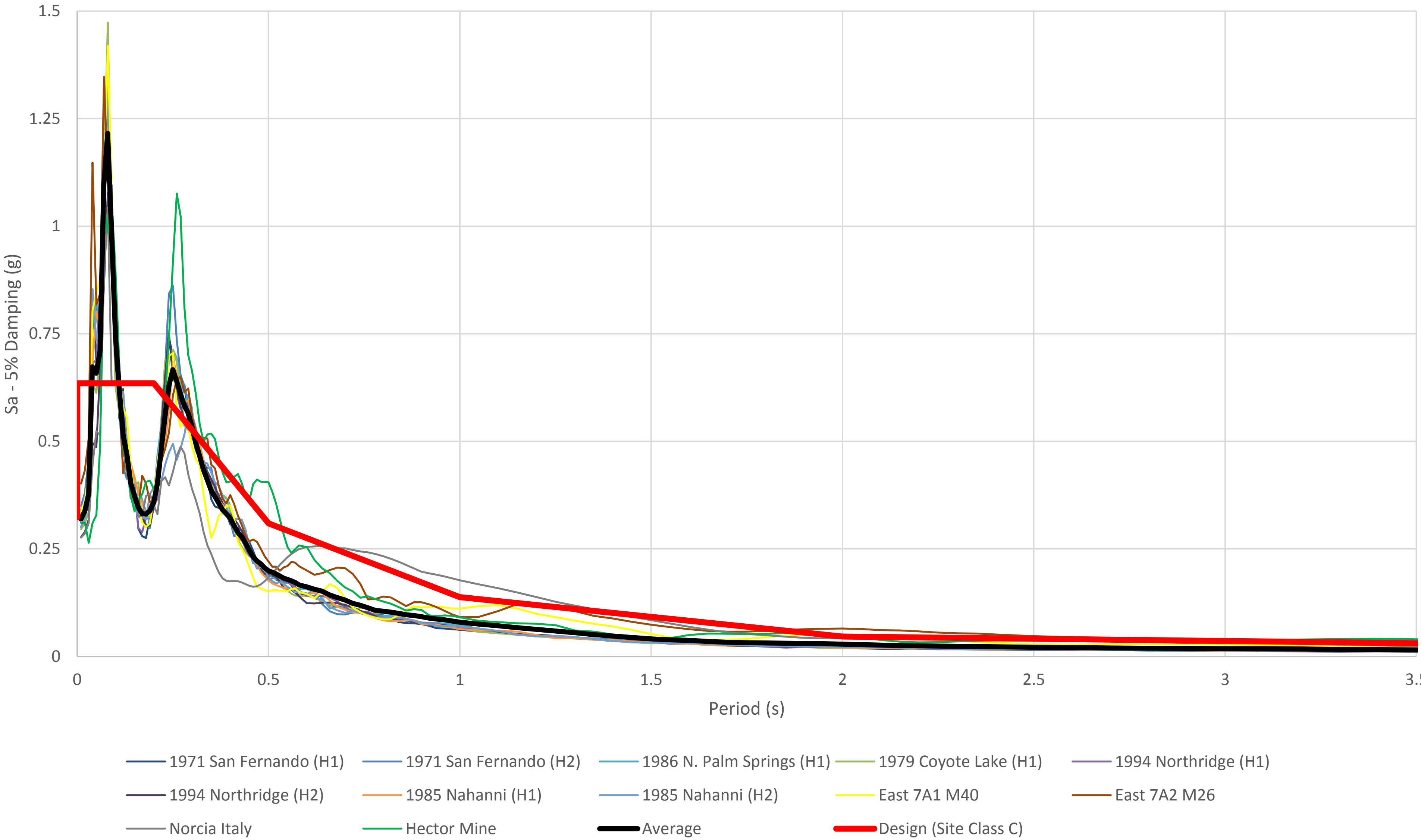
YYYY-MM-DD	2019-02-04
PREPARED	SG
DESIGN	SG
REVIEW	MJK
APPROVED	MJK

TITLE
Site Class A Scaled Input Response Spectra

PROJECT No.	Phase	Rev.	Figure
18106596	1000	1	1



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PREPARED	SG
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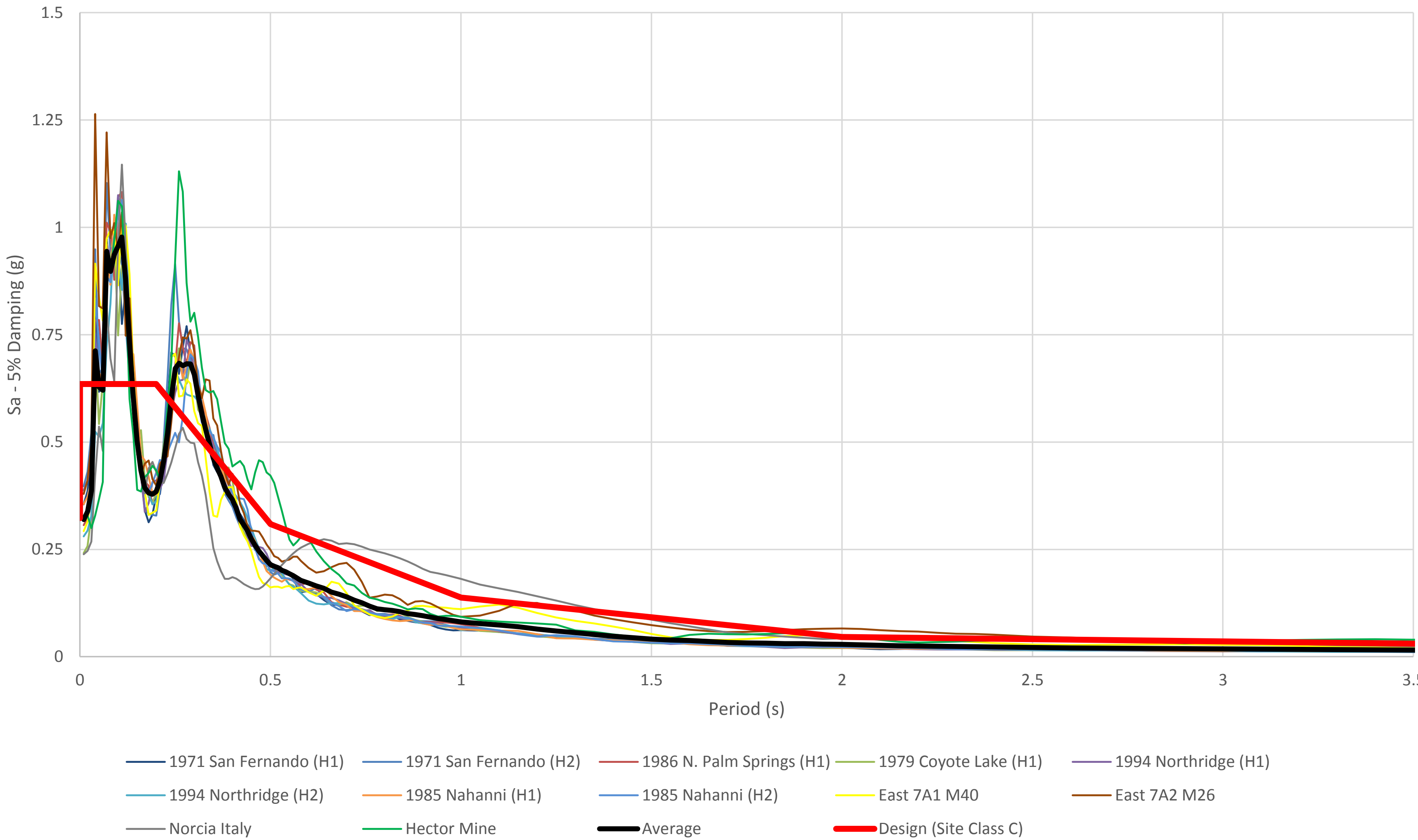
APPROVED	NRL

TITLE
Shake 2000 Output: Foundation Elevation (~71 masl)
Response Spectra – Shallow Bedrock Conditions (Profile 1)

PROJECT No.	Phase	Rev.	Figure
12-1121-0099	**1750**	**1**	**2**



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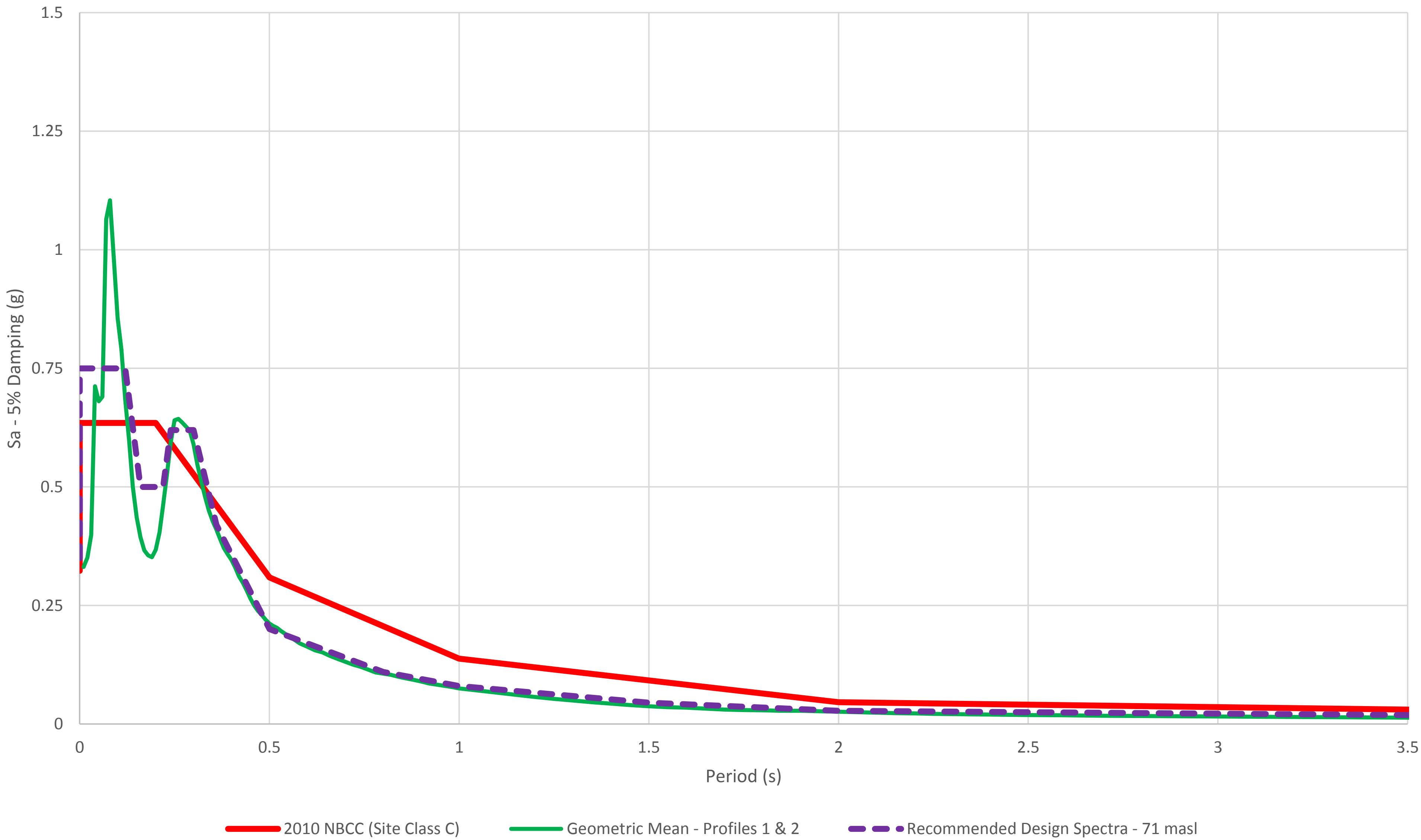
CONSULTANT GOLDER	YYYY-MM-DD: 2019-02-04 PREPARED: SG DESIGN: SG REVIEW: MJK APPROVED: NRL	TITLE **Shake 2000 Output: Foundation Elevation (~71 masl)** **Response Spectra – Deep Bedrock Conditions (Profile 2)**	

PROJECT No.	Phase	Rev.	Figure
12-1121-0099	**1750**	**1**	**3**



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YYYY-MM-DD	2019-02-04
PREPARED	SG
DESIGN	SG
REVIEW	MJK
APPROVED	NRL

TITLE
Recommended Site-Specific Design Spectra at Foundation Elevation (~71 masl)

PROJECT No.	Phase	Rev.	Figure
18106596	**1000**	**1**	**4**