Near-term Task Force Recommendation 2.1 Seismic Hazard Evaluation

Entergy

June 19, 2014

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References for Meeting

- Licensee Presentation Slides – ML14169A072
- NRC Presentation Slides – ML14169A489
- Public Meeting Agenda – ML14161A361
- Meeting Feedback Form (request from mfb@nrc.gov)
- May 9, 2014, NRC letter regarding Seismic Screening and Prioritization Results for central and eastern US Licensees (ML14111A147)
- May 21, 2014, NRC memo providing preliminary staff ground motion response spectra for central and eastern Licensees (ML14136A126)
- Meeting Summary to be issued within 30-day

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Meeting Introduction

Purpose: support information exchange and begin dialog to have common understanding of the causes of the primary differences between the preliminary NRC and licensee seismic hazard results

Background: NRC and licensee seismic hazard require resolution to support a final seismic screening decision and to support related follow-on submittals

Outcomes:

- Begin NRC and licensee resolution to support regulatory decisions and development of seismic risk evaluations, as appropriate
- Establish resolution path, including timelines and identification of potential information needs

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Look-ahead: Potential Next Steps

- NRC will consider the meeting information
- Potential paths:
  - Licensee submits supplemental information based on public meeting dialog
  - NRC staff issues a request for information
  - Licensee sends a revision or supplement to the seismic hazard report
- NRC completes screening review and issues the final screening determination letter

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NTTF Recommendation 2.1- Summary of Preliminary Seismic Hazard Analysis: Indian Point Units 2 and 3

June 19, 2014

Jon Ake-NRC

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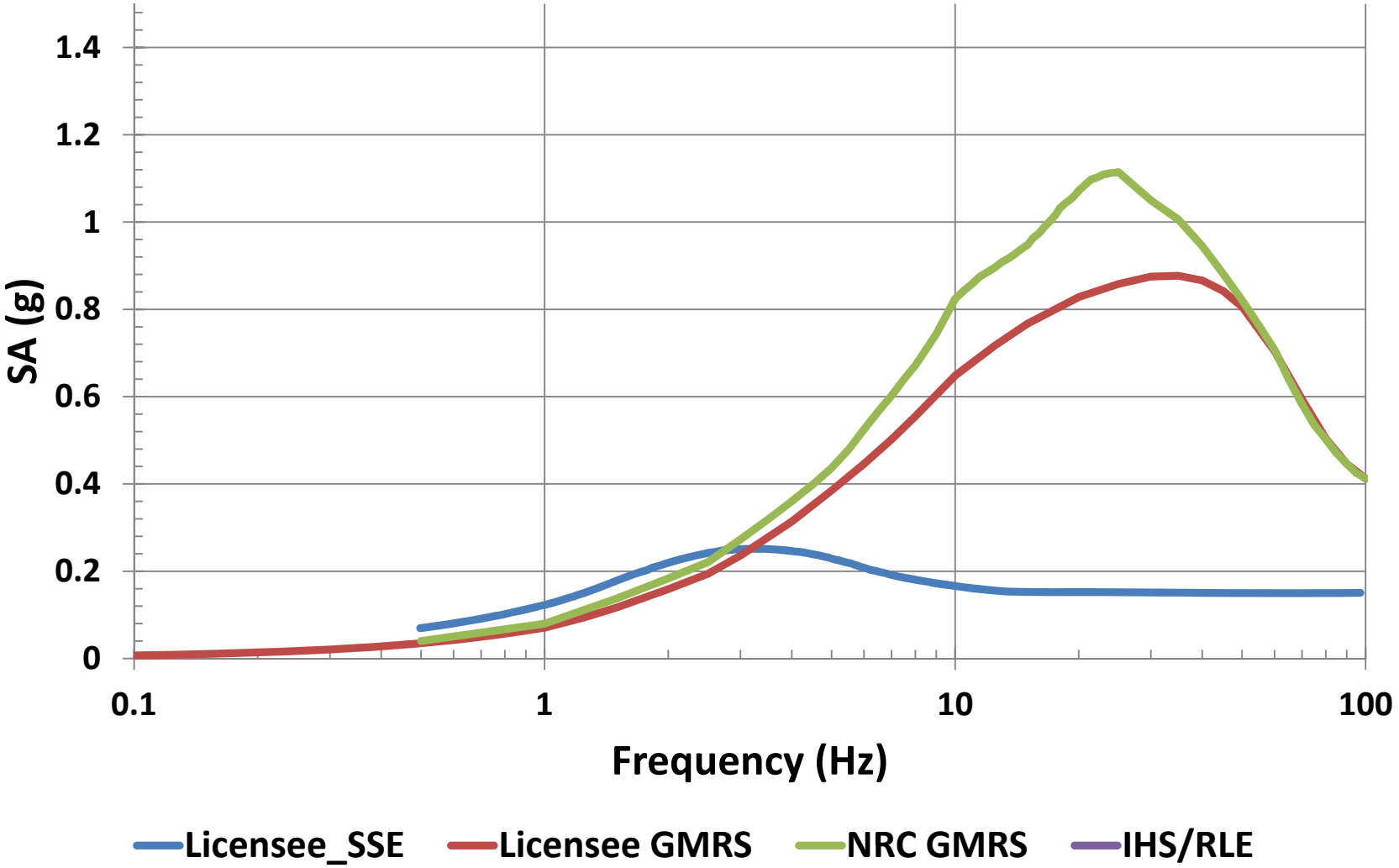
Indian Point 2



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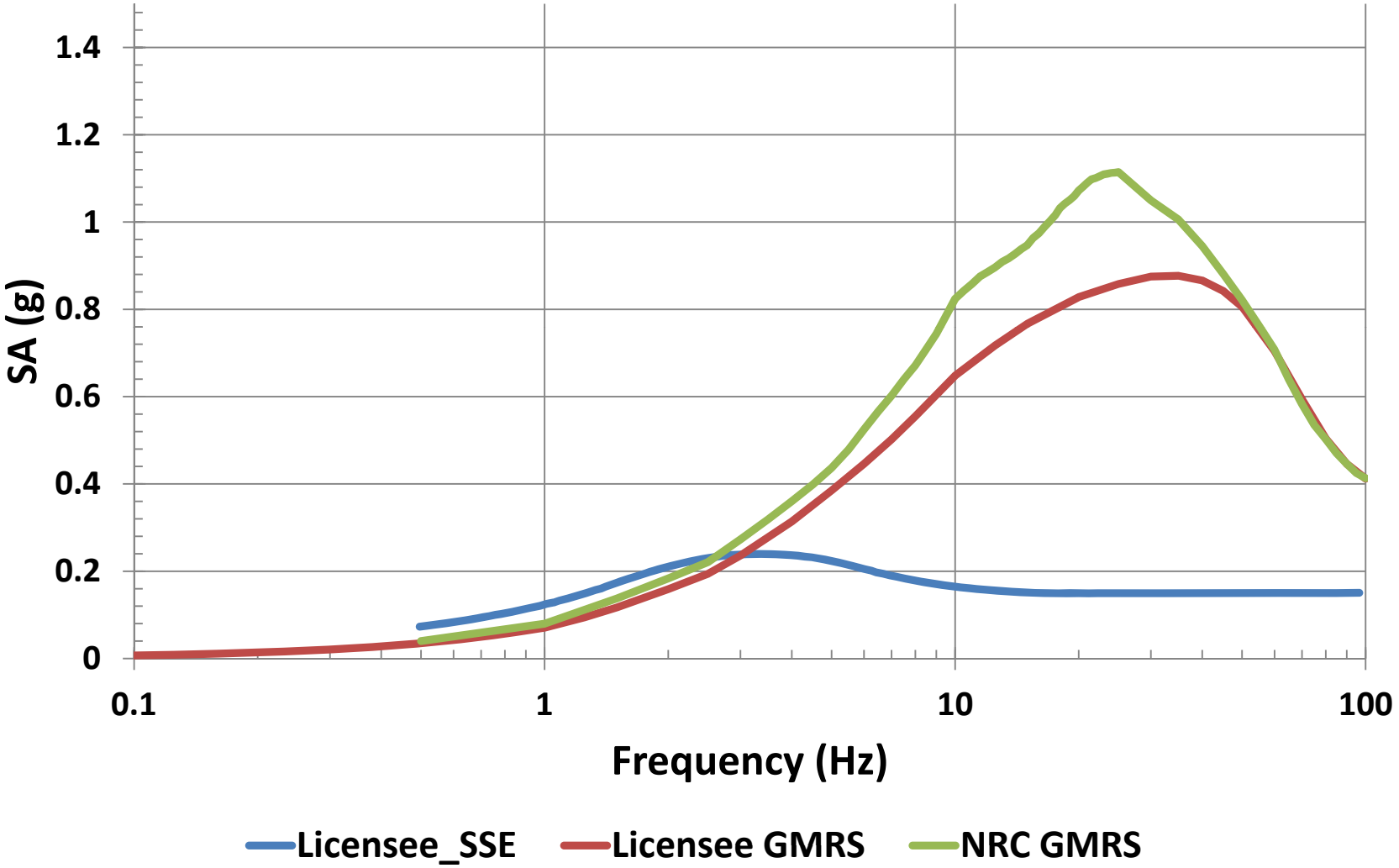
Indian Point 3



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Summary of Issues

- Licensee did not perform site response analysis. Cited P-wave refraction profile as justification
- NRC Staff used available on-site data and performed a site response analysis
- NRC staff concludes both Units ***screen-in*** for all risk evaluation activities
  - Difference due to site response, not rock hazard
- Additional information on plant-level capacity was included in IP3 submittal.
  - Used to support Section 5 Interim Actions of March Seismic Hazard and Screening Report submittal

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Partial List of References Used

- IP UFSAR Rev. 23 (IP2)
- GZA, 2008, Hydrogeologic Site Investigation Report for the Indian Point Energy Center. ML102910404 (FOIA web package)
- Licensee September 2013 and March 2014 submittals
- Memorandum on Geologic Features of Indian Point Nuclear Power Plant Site by T. Fluhr (memo in FSAR appendix)
- Guidebook to Geologic Field trip: Cortlandt Igneous Complex, Buchanan, NY (2008)
- Merguerian, C., et al., 2011, Stratigraphy, structural geology and metamorphism of the Inwood Marble Formation, northern Manhattan, NYC, NY: *in* Hanson, G. N., *chm*., Eighteenth Annual Conference on Geology of Long Island and Metropolitan New York, 09 April 2011, State University of New York at Stony Brook, NY, Long Island Geologists Program with Abstracts, 19 p.
- Various on-line sources for velocities of marble etc
- Site Geologic Report for Indian Point No. 2 and Indian Point No.3 Nuclear Power Plants
- Geology, Geochemistry, and Tectonostratigraphic Relations of the Crystalline Basement Beneath the New Jersey Coastal Plain and Contiguous Areas: USGS Prof. Paper 1565-B.

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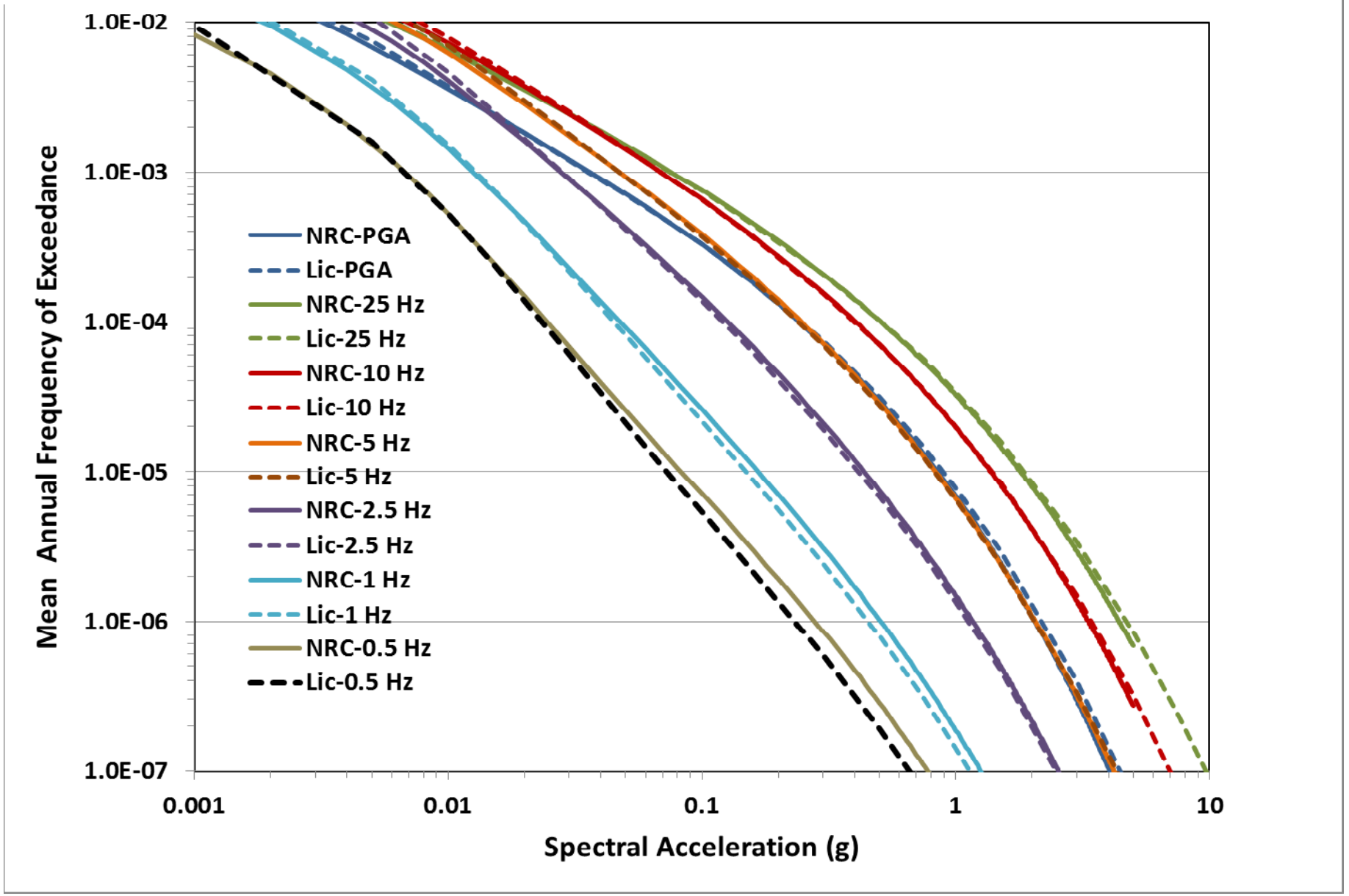
Rock Hazard Curve Comparison: Indian Point



FSAR Version 23 (IP2)

- "The Geology.
- The property as a whole is underlain by three geologic rock formations. They are:
- (a) A Phyllite or Schist. This is the uppermost formation of sedimentary origin. In some places the rock is a fine-grained phyllite resembling the phyllite of the Hudson River series. In other places it is a muscovite schist resembling the Manhattan schist found typically in New York City.
- (b) Beneath the phyllite or schist, and apparently conformable with it, is a limestone. Most of this is coarsely crystalline white or gray limestone, with some dolomitic and silicious bands, and a few quartz veins. Its original bedding structure has been obscured in part by shearing and jointing.
- (c) The schist, in the easterly part of the tract, about a half-mile east of the Hudson River, has been intruded by basic igneous rocks, known as the Cortlandt Series."
-
- "**The limestone has a well-defined layered structure**, believed to be original bedding, which strikes N-S to N E and dips easterly at 45 to 65 degrees. This layered structure is marked by shear planes and, rarely, thin shaly layers. The notable feature of the limestone is its extremely jointed condition. A major joint system extends at about right angles to the bedding structure, but, in addition, there are also many irregular joints. The jointing has an intensity which might almost be described as brecciation.
- The joints are open, but few display decay. This limestone formation is not cavernous. The limestone is hard, because of its jointed condition, it is my opinion that its supporting value for foundation purposes should be held to no more than 50 tons per square foot." (T. Fluhr, Memo)
-
- "North and east of the plant are hills and ridges of phyllite and schist."
- **The "limestone" is in fact the Ordivician Linwood "Marble"**

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General Site Stratigraphy

- Manhattan Schist (Ordivician)
- Inwood Marble (Lower Ordivician to Upper Cambrian)
- Lowerre Quartzite (Cambrian)
- Fordham Gneiss (Pre-Cambrian)
- Intrusive Complex Rocks

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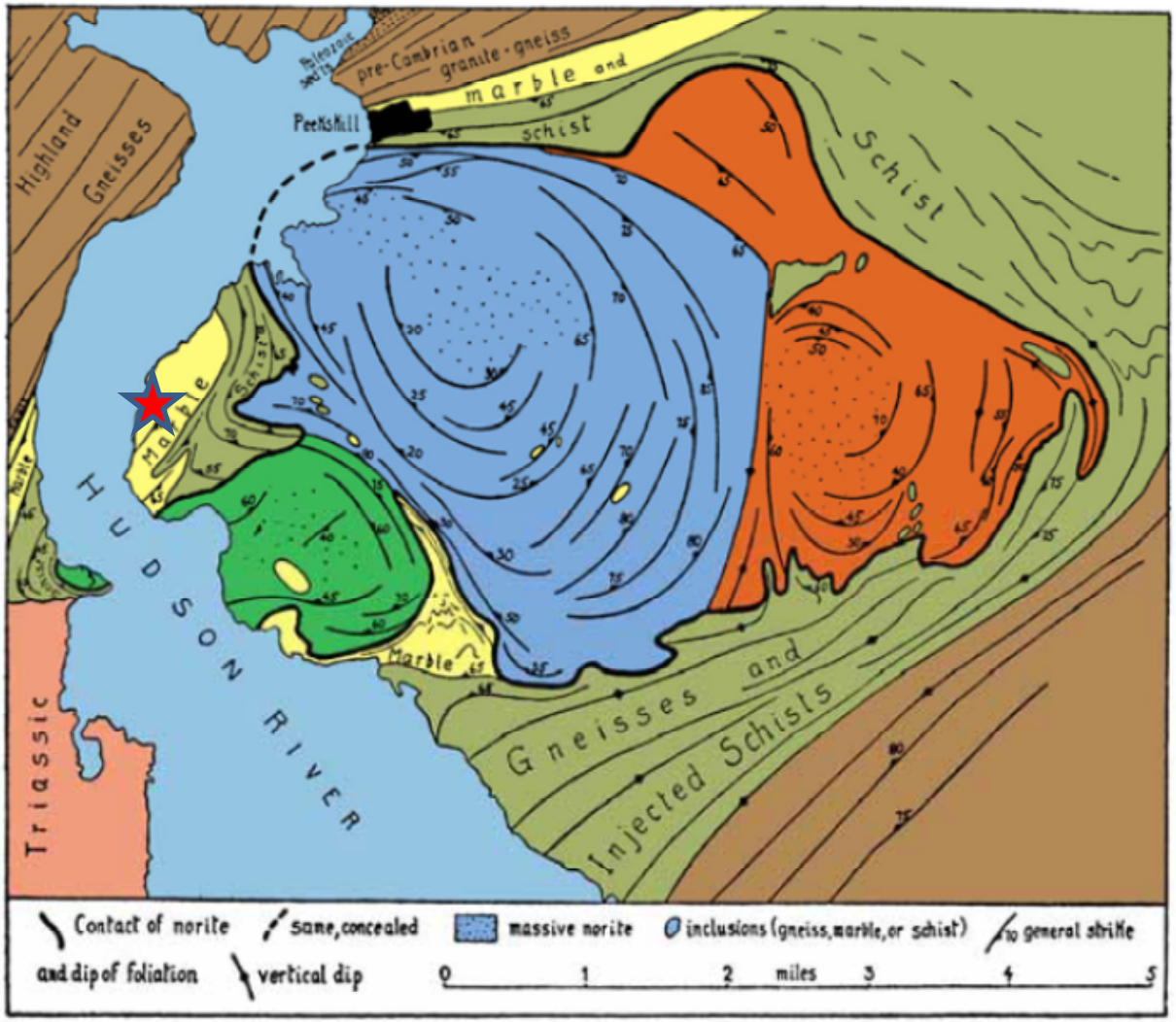
Indian Point: Local Geology



From Guide to Courtland Igneous Complex, 2008.

Bedrock: Inwood Marble w/Manhattan schist present in northeastern portion of site

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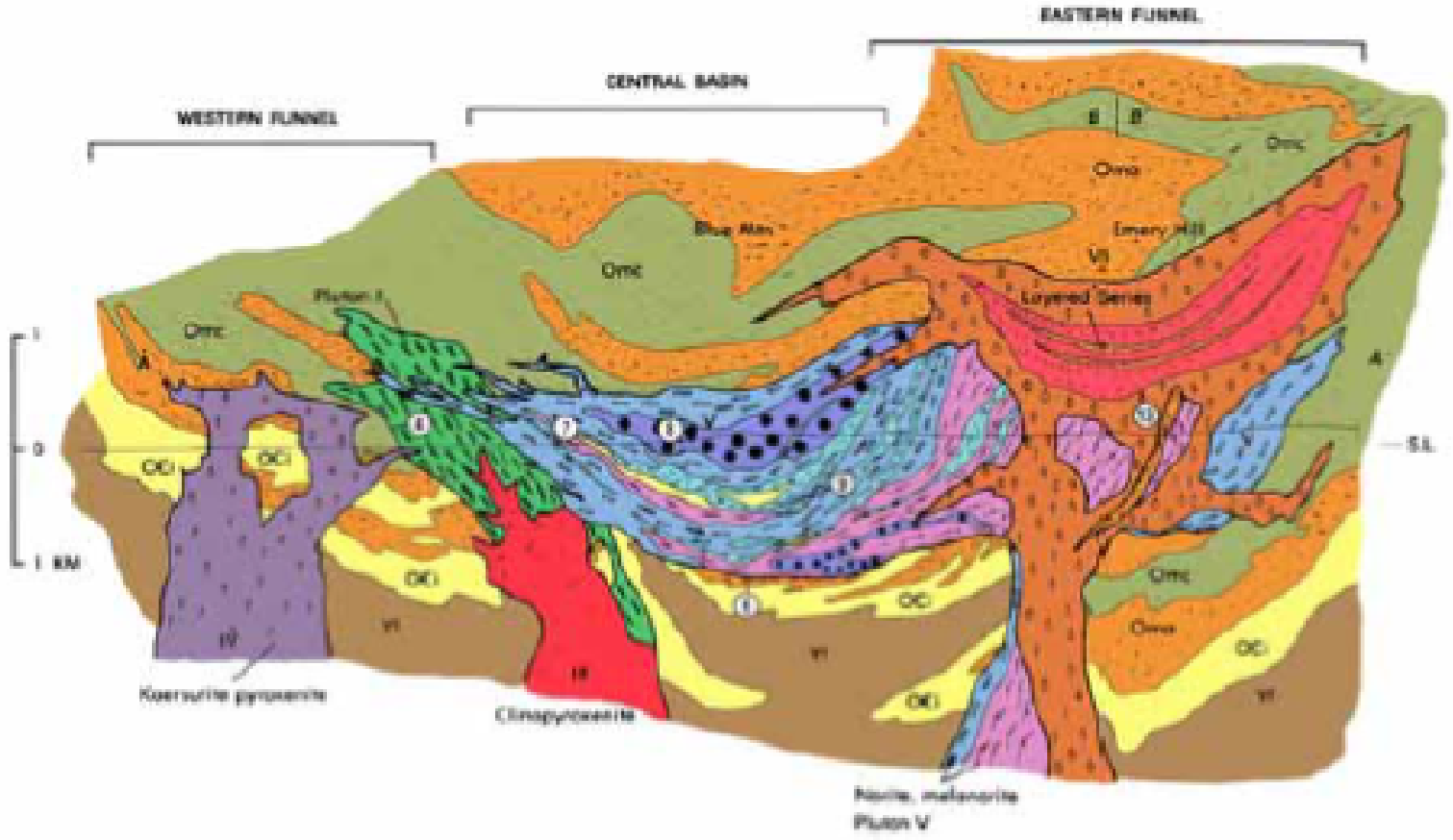
Complex Sub-surface Geology



From Guide to Courtland Igneous Complex, 2008.

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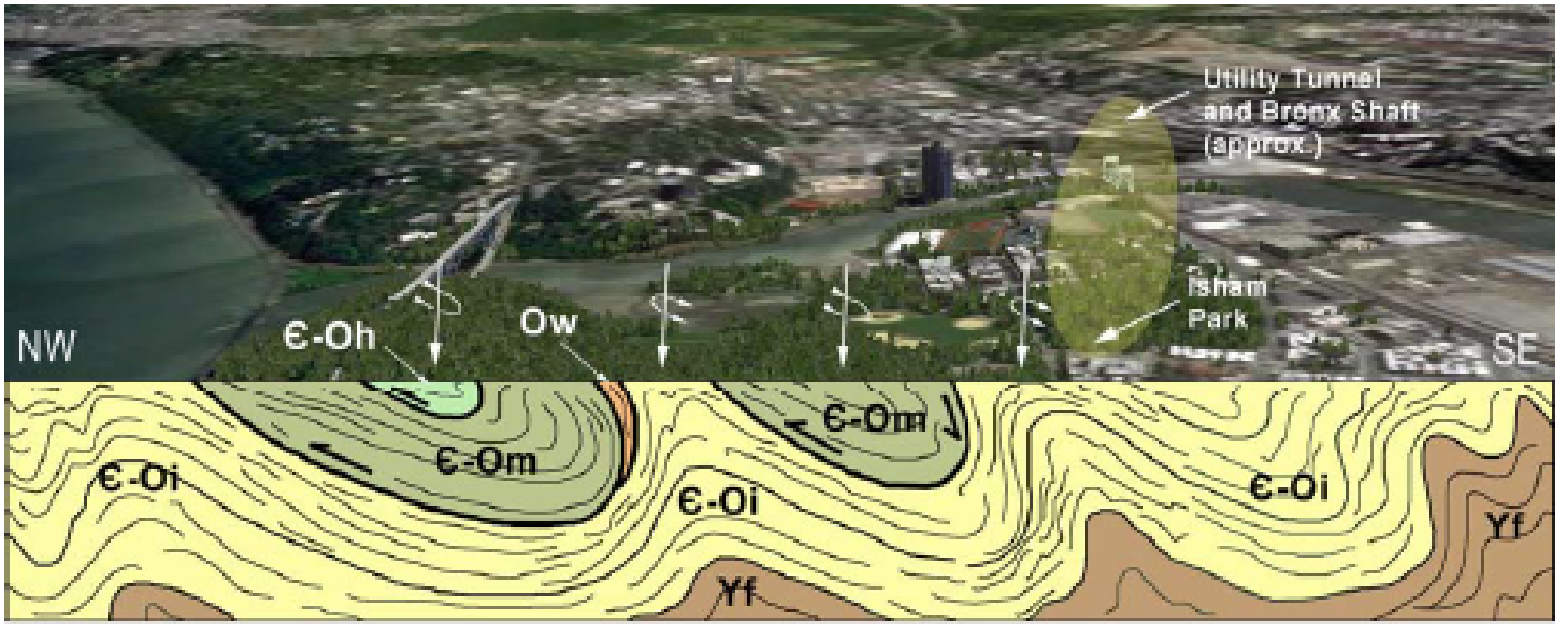
Geologic section of Inwood in Upper Manhattan (type section)



Based on regional observations: assume that the Cambrian Quartzite
And underlying units have a Vs > Vs reference

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Control Point

- Indian Point is a firm rock site. Consistent with SPID the Control Point is defined as the top/surface of the rock unit (the Inwood Marble).
- To reiterate: it has been assumed that the underlying Ordovician Lourre Quartzite and underlying gneisses and intrusives have a velocity >= 9200 fps (reference rock velocity).

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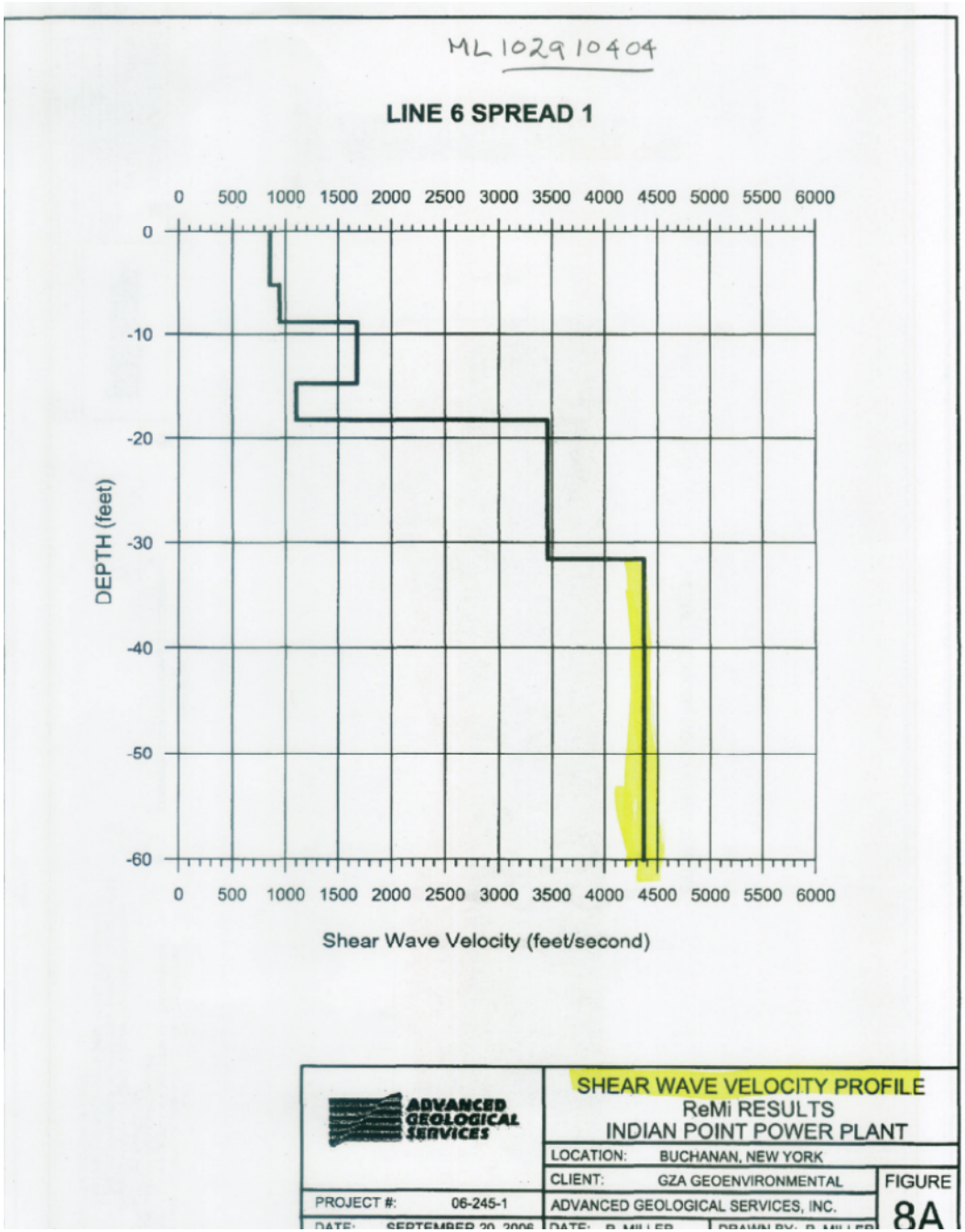
Additional Information Available for the Indian Point Site

- "Between 2005 and 2007, GZA GeoEnvironmental (GZA), performed a comprehensive hydrogeologic investigation of the site. This investigation was initiated to understand groundwater flow and contaminant transport. During this investigation numerous borings were advanced to study the site geology, hydrology and aquifer properties. Details of the geology, hydrology and aquifer properties can be found in the GZA report."
- From Rev 23 of IP2 FSAR (**Hydrology Section**)



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Shear-wave velocity profile from IP site.

13 profiles acquired with Surface wave-technique- All penetrated bedrock

(from GZA Hydrogeology report, Appendix O)
ML 102910404

Very consistent velocities in upper portion of bedrock (Inwood)

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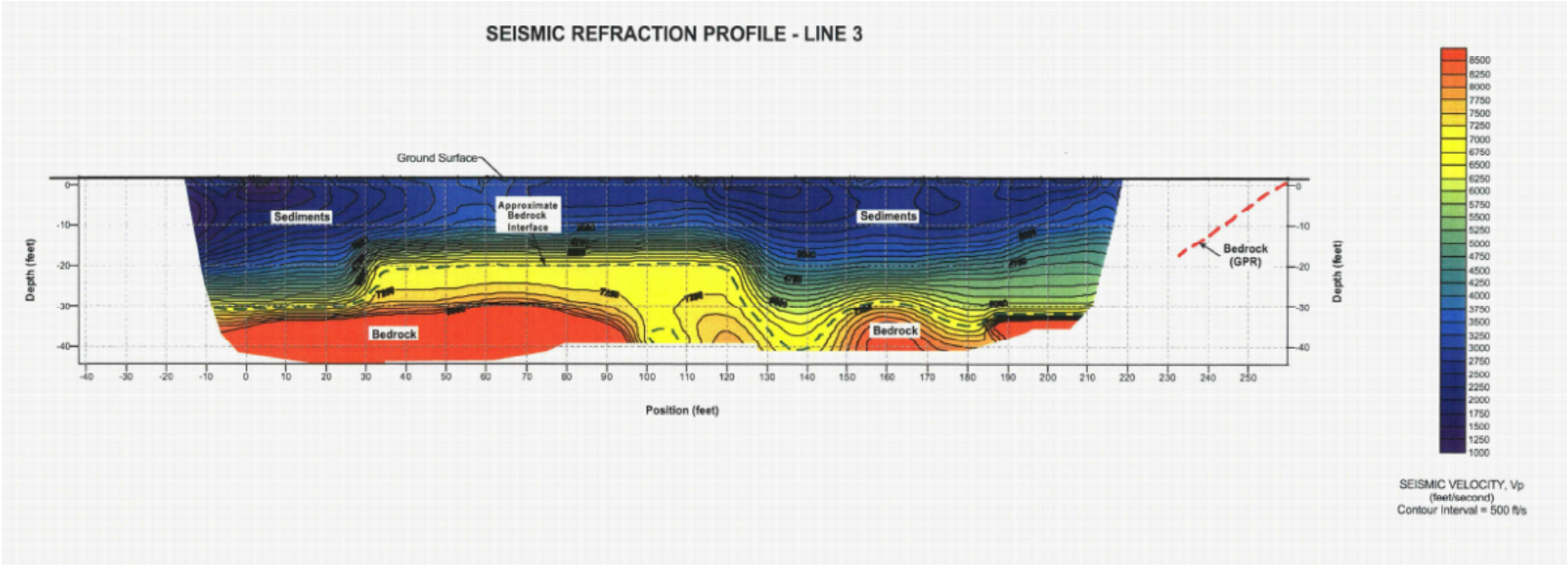
GZA Report: Seismic Profiles



Independent P-wave data indicates Vp ~8-9000 fps in near surface.

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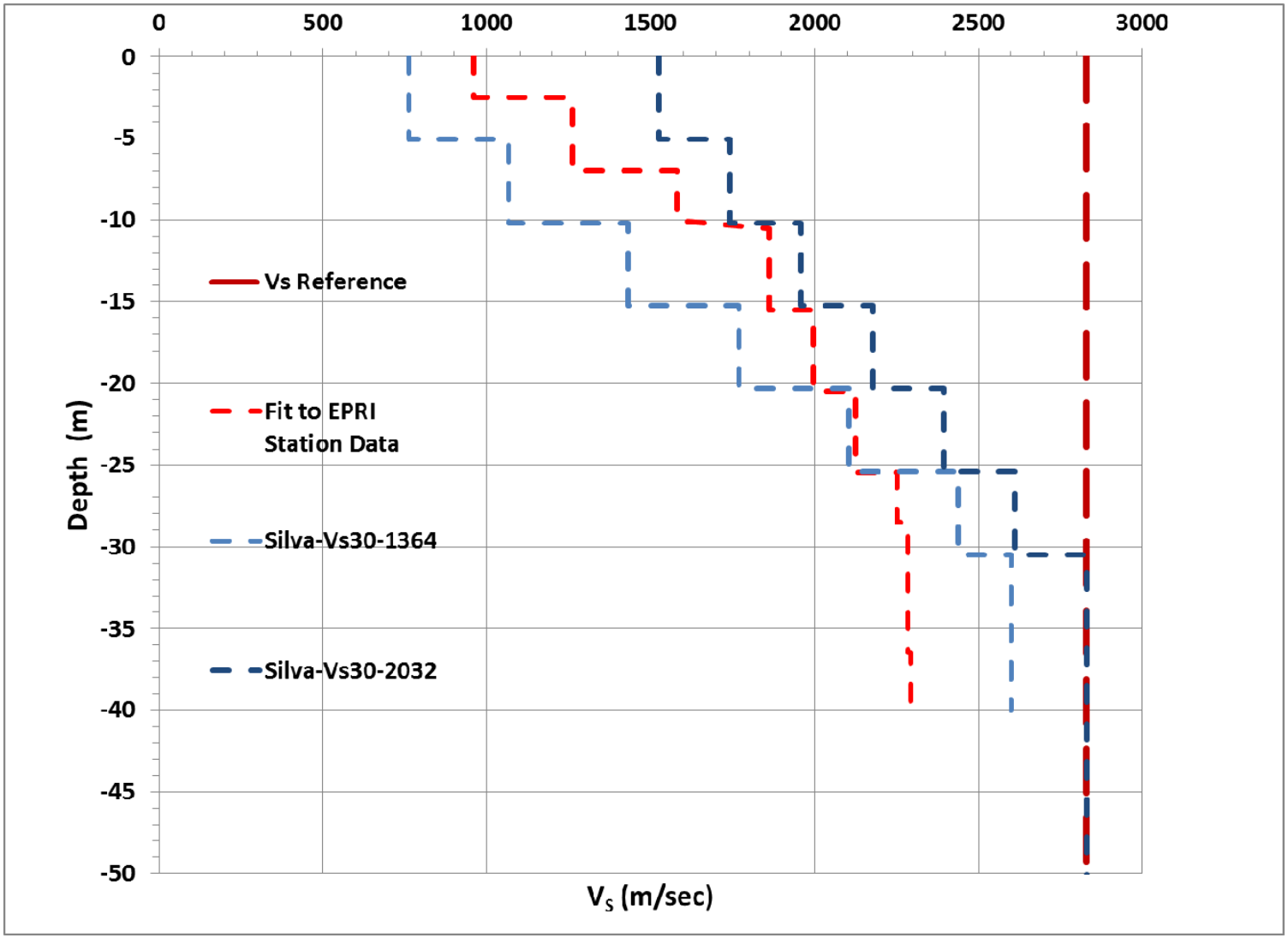
IP Velocity Profiles Informed with Template Profiles



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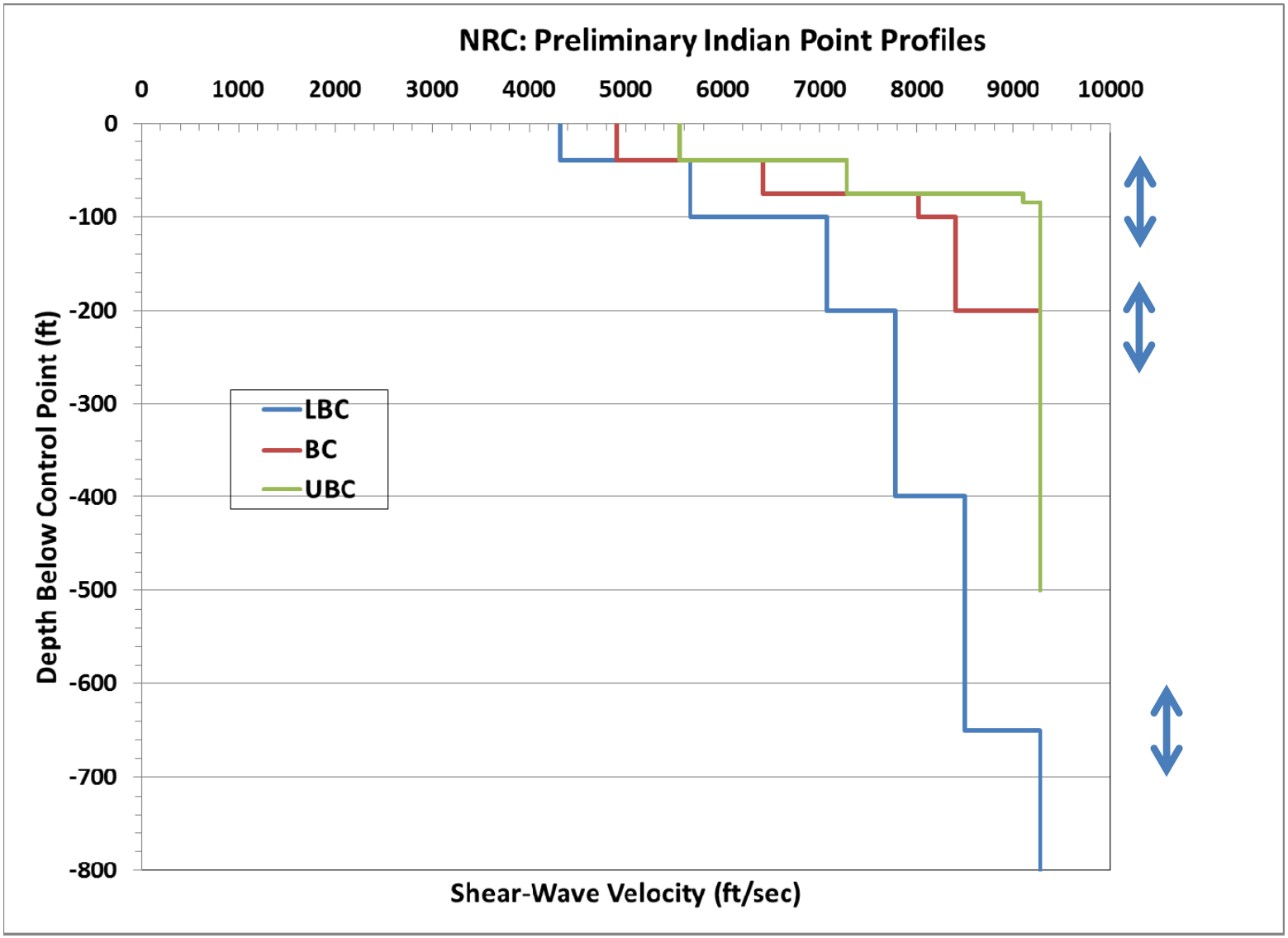
Profiles Used in NRC Analysis



Preliminary Indian Point Site Response Model

Layer	Depth (ft)	Velocity (ft/s)	Sigma-ln (Vs)	G/Gmax&D	G/Gmax&D
BC-1	0-40	4900	0.15	EPRI Rock	Linear-1%
BC-2	40-75	6419	0.15	EPRI Rock	Linear-1%
BC-3	75-100	8024	0.15	EPRI Rock	Linear-1%
BC-4	100-200	8400	0.15	Linear-ND	Linear-ND
LBC-1	0-40	4320	0.15	EPRI Rock	Linear-1%
LBC-2	40-100	5662	0.15	EPRI Rock	Linear-1%
LBC-3	100-200	7077	0.15	EPRI Rock	Linear-1%
LBC-3	200-400	7785	0.15	Linear-ND	Linear-ND
LBC-4	400-800	8500	0.15	Linear-ND	Linear-ND
UBC-1	0-40	5555	0.15	EPRI Rock	Linear-1%
UBC-2	40-75	7277	0.15	EPRI Rock	Linear-1%
UBC-3	75-85	9000	0.10	EPRI Rock	Linear-1%

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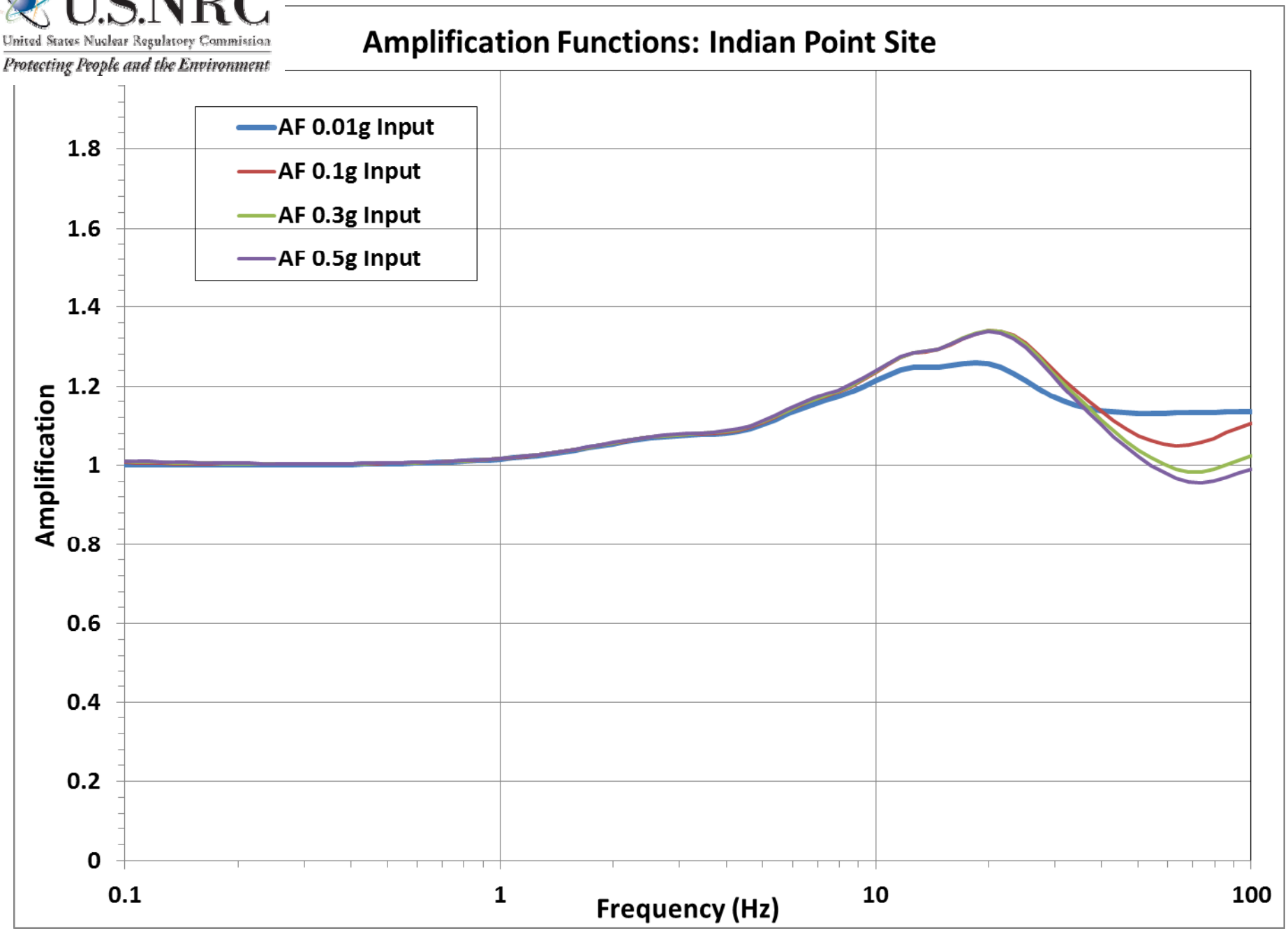

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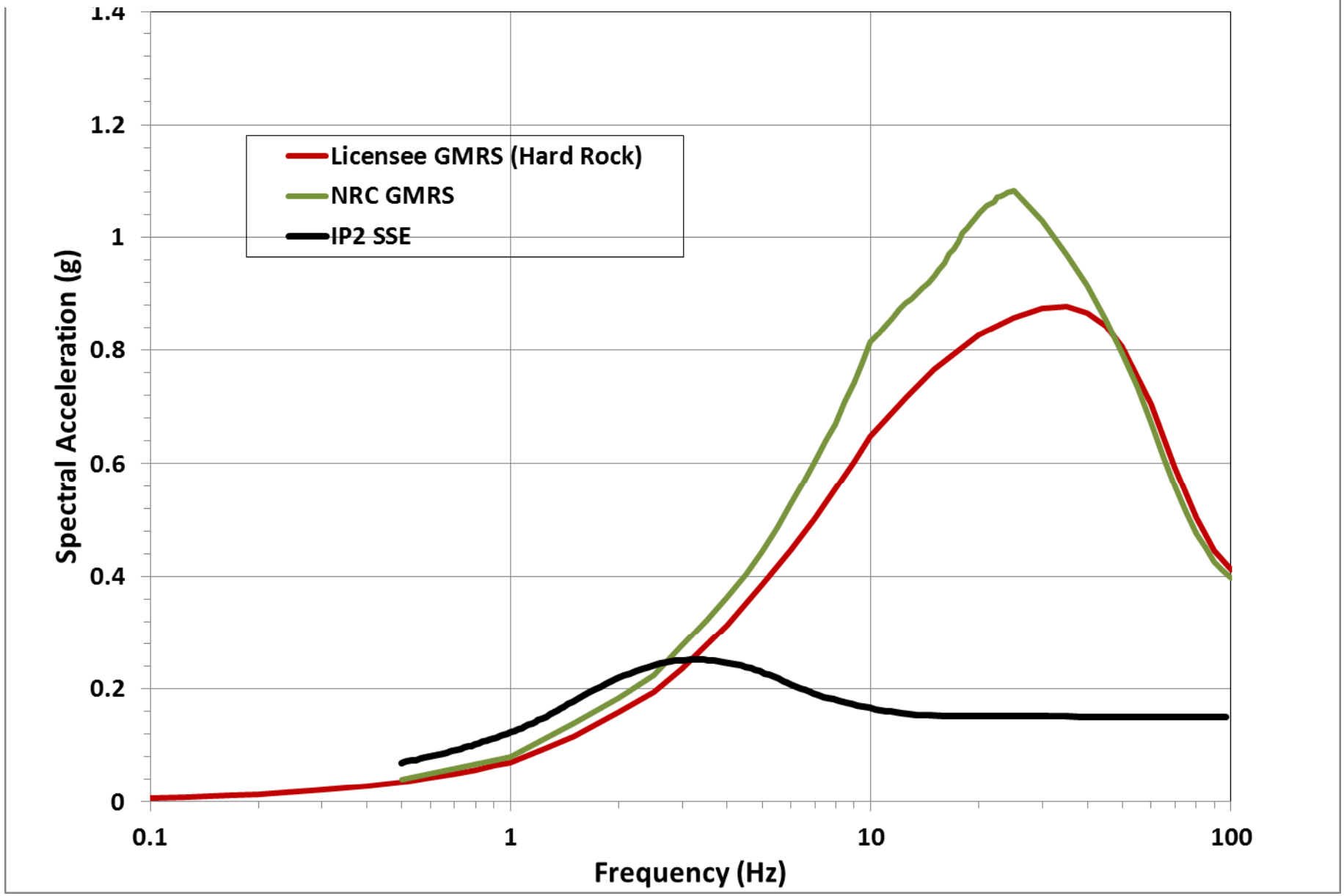
Spectral Comparison: Indian Point Site



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Why P-Wave Refraction Results Should be Used With Caution Here

Conclusion based on results of P-wave refraction. Velocities of 8000-16,000 fps cited.

Significant layered (bedding) in near-vertical attitude. Discontinous "stringers" of very hard material. Very easy (maybe impossible not to) to bias refraction results to high value.

Vs for these Vp values: 4600-8550 fps (assuming nu =0.3).

Existence of direct shear-wave results

From- Merguerian, C., et al., 2011