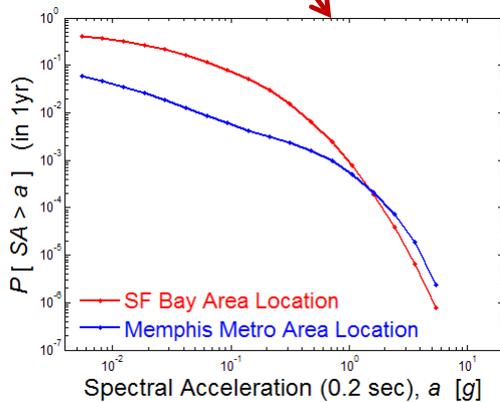
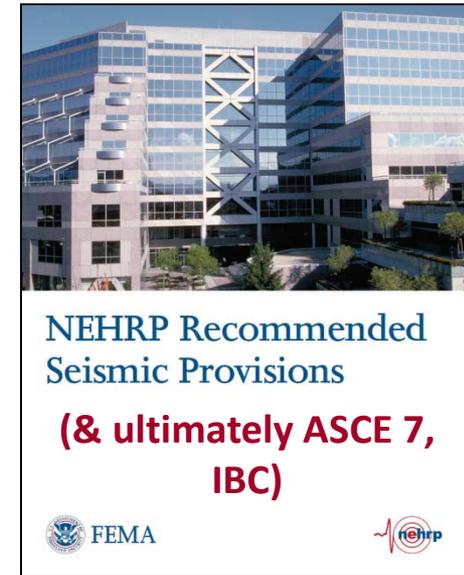
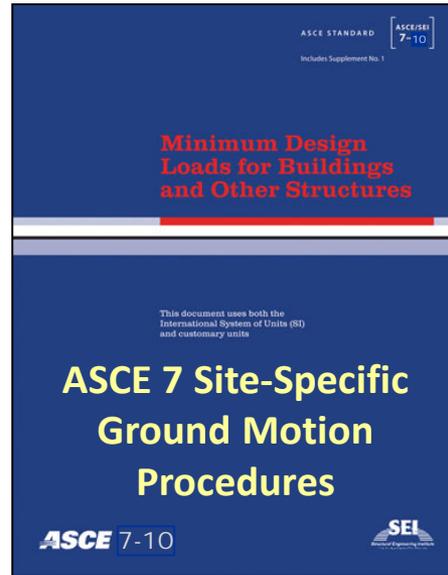
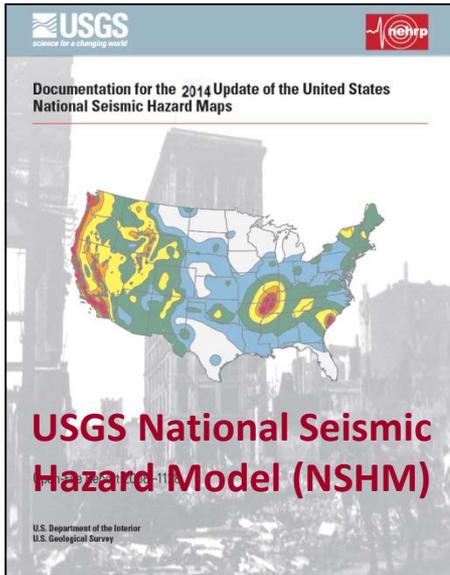


# Project '17: A Collaboration of the USGS National Seismic Hazard Mapping Project & Engineers to Develop Ground Motion Maps for the 2024 International Building Code

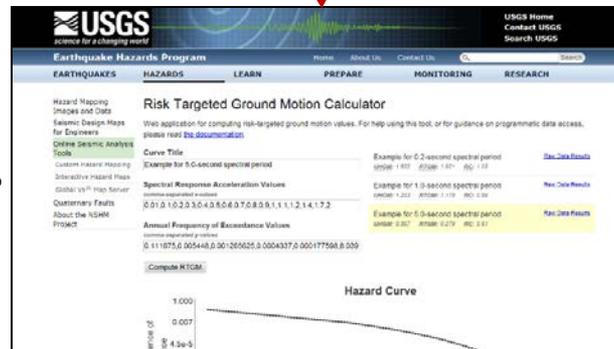
Nicolas Luco

Research Structural Engineer

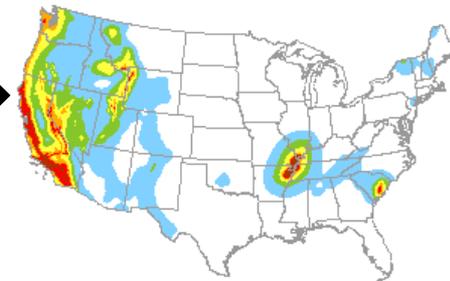
USGS – Golden, CO



+



**MCE<sub>R</sub> Ground Motion Map**



# Motivation

**Design maps derived from 2014 USGS NSHM have been voted into the 2015 NEHRP Provisions, but with several “no” votes, e.g., ...**

*“The updates are generating significant fluctuations in seismic design criteria. These fluctuations imply to the design community that criteria are being set without adequate rigor. The fluctuations also create significant hardship for building owners who make significant structural changes and find that a building adequate under a previous code become substantially inadequate under the new code. Further discussion of the overall seismic map direction and its impact on users is needed.”*

# “Project ‘17”

- For development of design maps for *2020/21 NEHRP Provisions* (& *2024 International Building Code*)
- Collaboration of FEMA (which funds Building Seismic Safety Council, BSSC) & USGS (NSHMP)
- Sequel to Project '97 (*2000 IBC*) & Project '07 (*2012 IBC*)
- Planning committee formed, to identify issues for potential proposals to change the existing design maps
- Final planning committee meeting to be held in August(2015)

# Current List of Issues

1. *Timing for updates*
2. *Medium for conveyance*
3. *Precision & uncertainty*
4. Acceptable collapse risk
5. Collapse fragility
6. Max-direction ground motions
7. *Multi-period spectra*
8. Duration effects
9. Damping levels
10. Vertical ground motions
11. *Deterministic caps*
12. Basin effects
13. *Use of 3-D simulations*

# 1. Timing for Updates

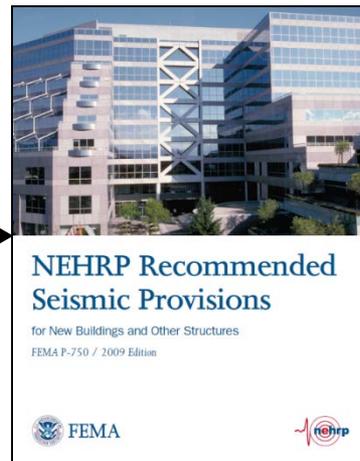
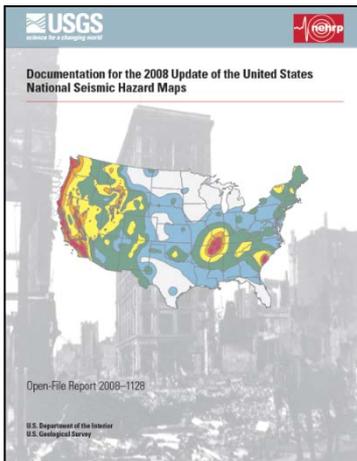
USGS NSHM	NEHRP Provisions	ASCE 7 Standard	IBC
1996	1997, 2000	1998, 2002	2000, 20003
2002	2003	2005	2006, 2009
2008	2009	2010	2012, 2015
2014	2015	2016	2018

**2017/18**

**2020/21**

**2022**

**2024**



**FEMA**



# 1. Timing for Updates

- USGS debating whether to update National Seismic Hazard Model (NSHM) every 3 years.
- *Pro:* Reduced amount of modeling changes in each update.
- *Pro:* More frequent opportunities for external contributors to submit their information.
- *Con:* More overhead, e.g., for documentation.
- *Con:* Existence of “interim” updates that are not incorporated into NEHRP Provisions, etc.

# 1. Timing for Updates

- *Importance* – Updated NSHM needed for several other potential Project 17 issues (e.g., multi-period spectra), so timing must be coordinated between USGS, its external contributors, and NEHRP Provisions.
- *Risks* – Only of not coordinating.
- *Resources* – Small issue team of managers, web conferences.
- *Schedule* – Beginning of Project ‘17.

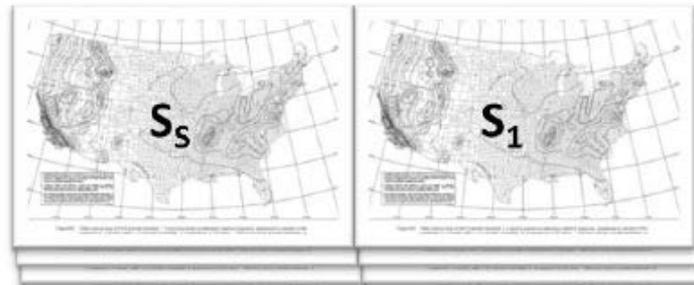
# 2. Design Value Conveyance

1991



1 Map

2000



14 Maps

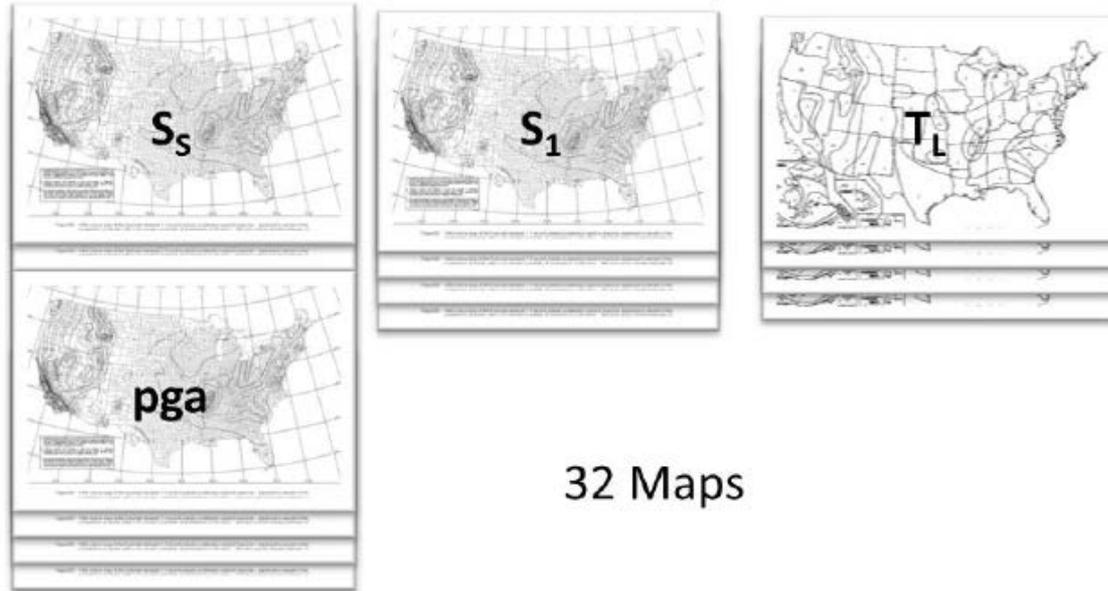
2005



20  
Maps

# 2. Design Value Conveyance

2010



32 Maps

## 2. Design Value Conveyance

2022



- Maps for:
  - 0 sec, 0.2 sec, 0.5 sec, 1 sec, 2sec, 2.5 sec, 3 sec....9 sec, 10sec.
  - $V_{s30}$ : <200m/s, 300m/s, 400 m/s, 500 m/s, 1000 m/s, >2000m/s
  - Damping .5%, 2.5%, 5%, 10%, 15%, 20%, 25%

# 2. Design Value Conveyance

U.S. Seismic Design Maps

For occasional announcements about this web tool, please visit our [U.S. Seismic Design Maps wiki](#).

**Application** Batch Mode Help

**Design Code Reference Document**  
Consult your local design official if you need help selecting this.  
2009 NEHRP

**Report Title (Optional)**  
This will appear at the top of the generated report.  
Example

**Site Soil Classification**  
This is not automatically selected based on site location.  
Site Class D – “Stiff Soil” (Default)

**Risk Category**  
Used to compute the seismic design category.  
I or II or III

**Site Latitude**  
Decimal degrees for the site location.  
36.1646989

**Site Longitude**  
Decimal degrees for the site location.  
-115.1509312

Map of Las Vegas showing seismic design maps. Coordinates: 36.348°N, 114.839°W. Powered by Leaflet — Tiles Courtesy of MapQuest — Data © OpenStreetMap contributors, C

**Can this become law?**  
**Do we want it to?**

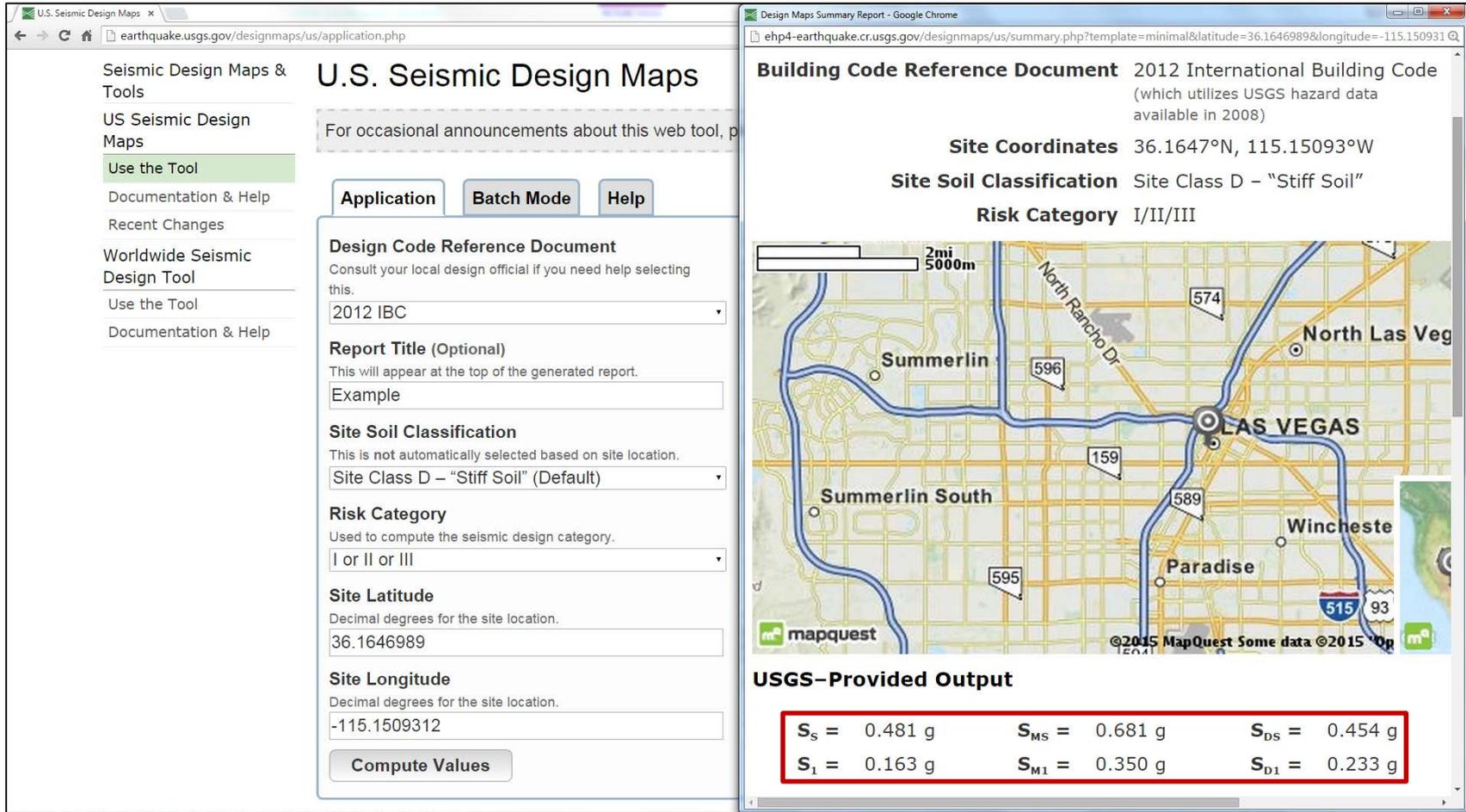
## 2. Design Value Conveyance

- During development of 2015 Provisions, addition of design maps for  $T=1.5$ , 2, & 3 seconds was considered.
- *“ $S_T =$  the  $MCE_R$  spectral response accelerations ... at periods of 1.5 s, 2 s, and 3 s, which shall be developed in accordance with Section 21.2.3, using the same probabilistic and deterministic ground motion hazard analysis models that are the bases for the mapped  $MCE_R$  spectral response accelerations of Chapter 22.”*

## 2. Design Value Conveyance

- *Importance* – Preparation, publication, and use of very large number of maps impractical.
- *Risks* – Increased reliance on web tool.
- *Resources* – Issue team of ICC, ANSI, and ASCE representative, in-person meetings. Web development.
- *Schedule* – First 6 months of Project '17.

# 3. Precision & Uncertainty



The screenshot shows the U.S. Seismic Design Maps web application interface. The left sidebar contains navigation links such as 'Seismic Design Maps & Tools', 'US Seismic Design Maps', and 'Worldwide Seismic Design Tool'. The main content area is titled 'U.S. Seismic Design Maps' and includes a 'Design Code Reference Document' dropdown set to '2012 IBC'. Other input fields include 'Report Title (Optional)', 'Site Soil Classification' (Site Class D - "Stiff Soil"), 'Risk Category' (I or II or III), 'Site Latitude' (36.1646989), and 'Site Longitude' (-115.1509312). A 'Compute Values' button is located at the bottom of the input section.

The right sidebar displays the 'Design Maps Summary Report' for a specific location. It includes the following information:

- Building Code Reference Document:** 2012 International Building Code (which utilizes USGS hazard data available in 2008)
- Site Coordinates:** 36.1647°N, 115.15093°W
- Site Soil Classification:** Site Class D – "Stiff Soil"
- Risk Category:** I/II/III

A map of the Las Vegas area is shown, with a red circle indicating the site location. The map includes labels for 'Summerlin', 'North Las Vegas', 'Paradise', and 'Winchester'. A scale bar indicates 2 miles or 5000 meters.

The 'USGS-Provided Output' section displays the following seismic hazard parameters:

$S_s = 0.481 \text{ g}$	$S_{MS} = 0.681 \text{ g}$	$S_{DS} = 0.454 \text{ g}$
$S_1 = 0.163 \text{ g}$	$S_{M1} = 0.350 \text{ g}$	$S_{D1} = 0.233 \text{ g}$

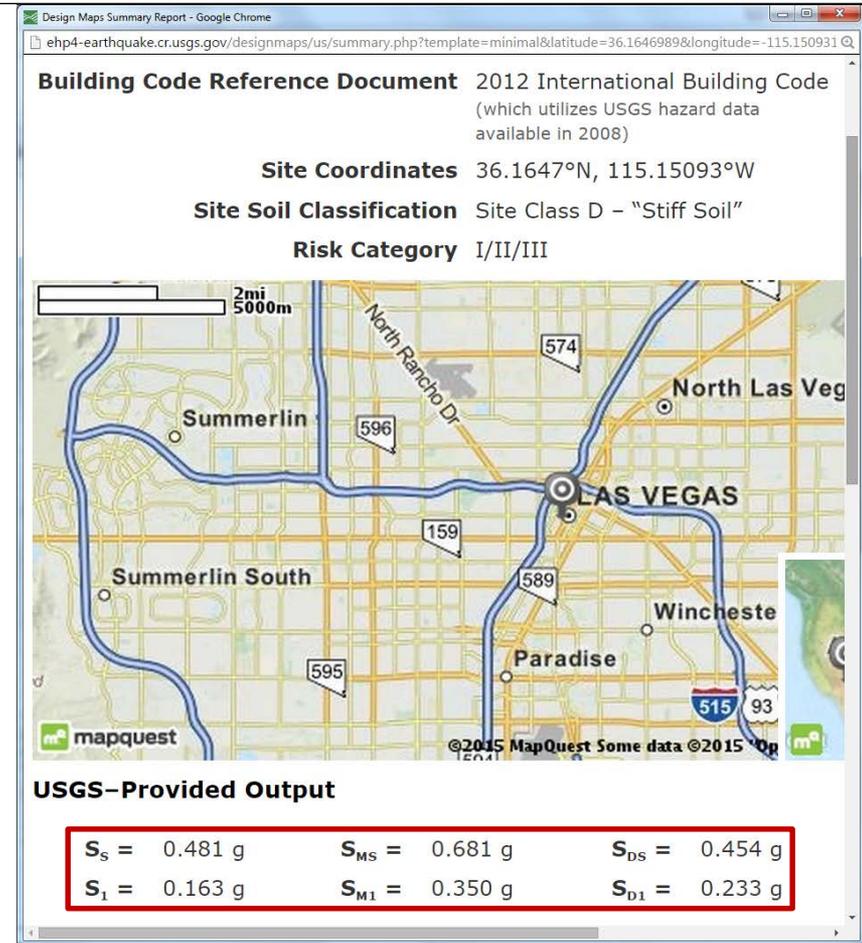
# 3. Precision & Uncertainty

**Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter**

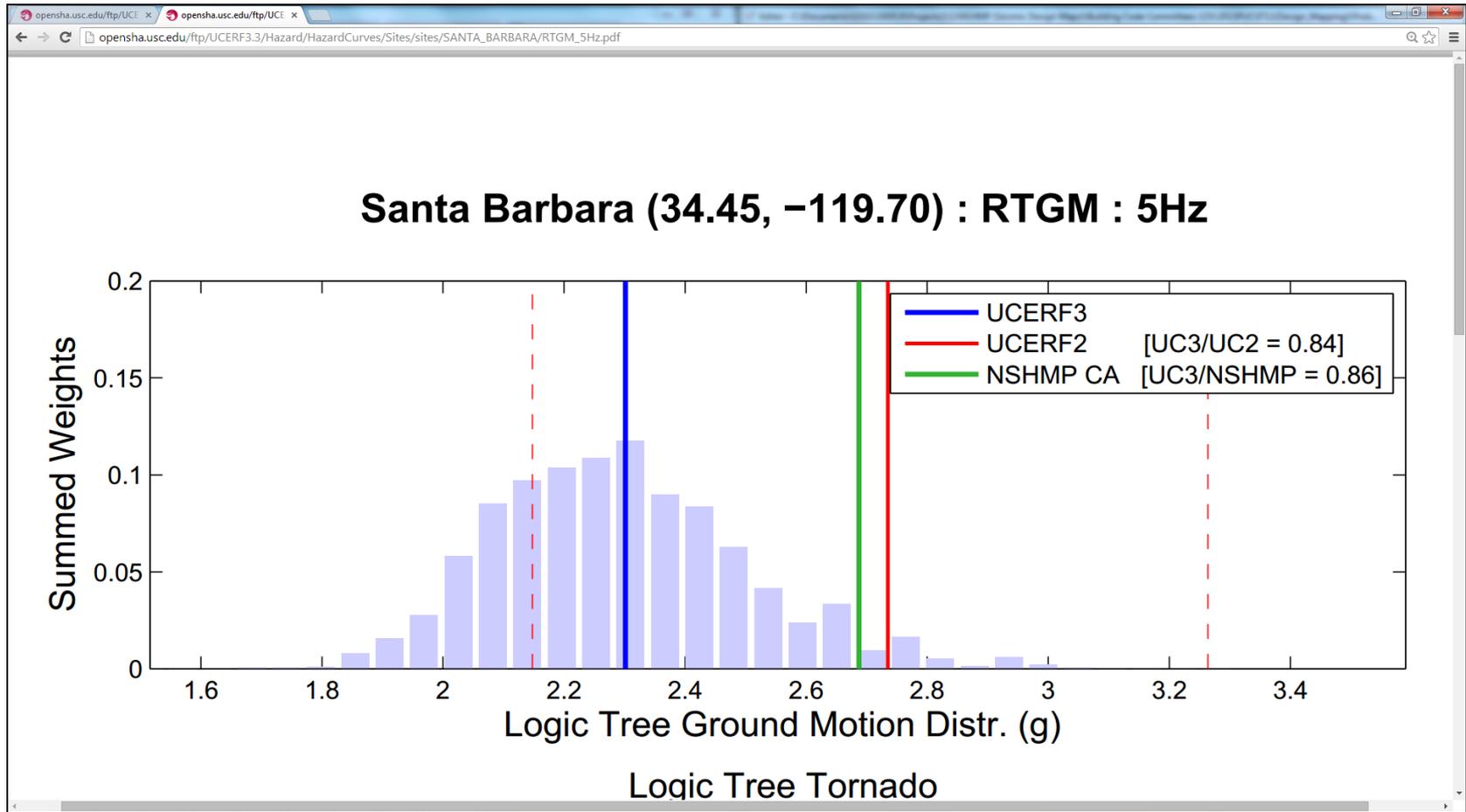
Value of $S_{DS}$	Risk Category	
	I or II or III	IV
$S_{DS} < 0.167$	A	A
$0.167 \leq S_{DS} < 0.33$	B	C
$0.33 \leq S_{DS} < 0.50$	C	D
$0.50 \leq S_{DS}$	D	D

**Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter**

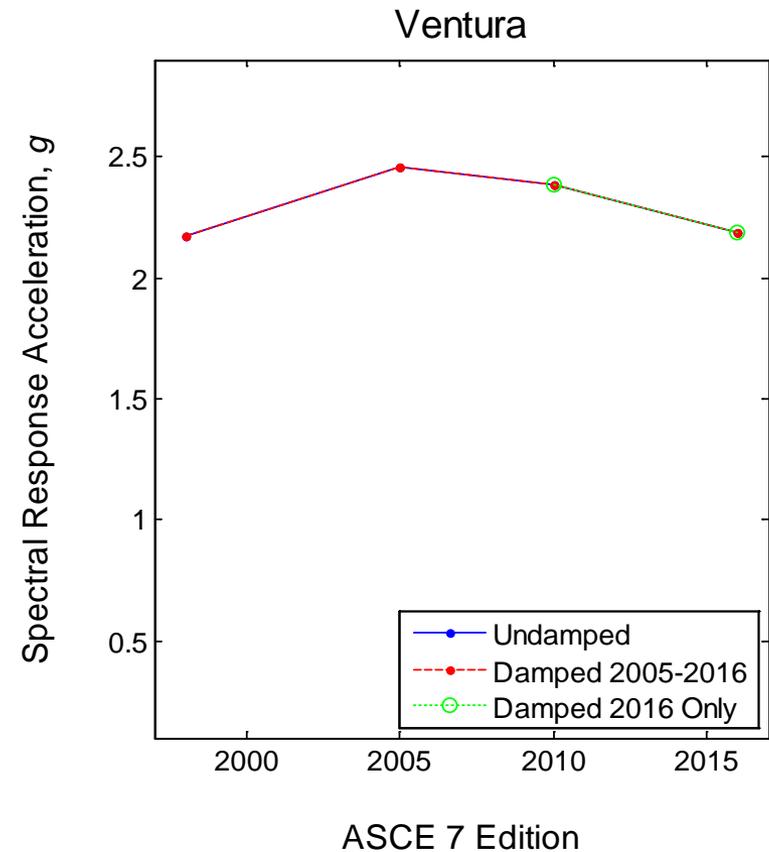
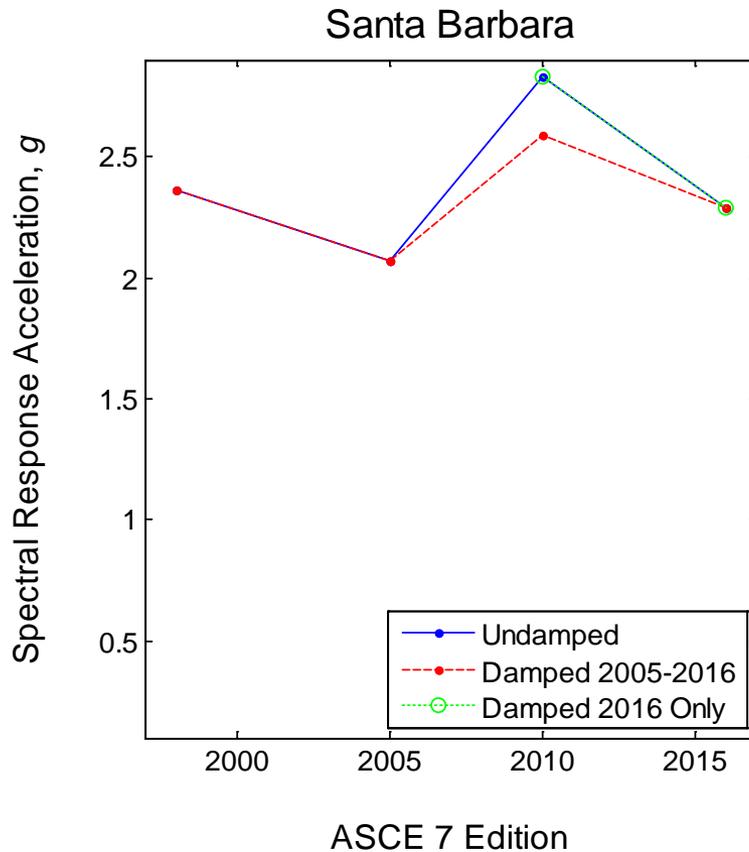
Value of $S_{D1}$	Risk Category	
	I or II or III	IV
$S_{D1} < 0.067$	A	A
$0.067 \leq S_{D1} < 0.133$	B	C
$0.133 \leq S_{D1} < 0.20$	C	D
$0.20 \leq S_{D1}$	D	D



# 3. Precision & Uncertainty



# 3. Precision & Uncertainty

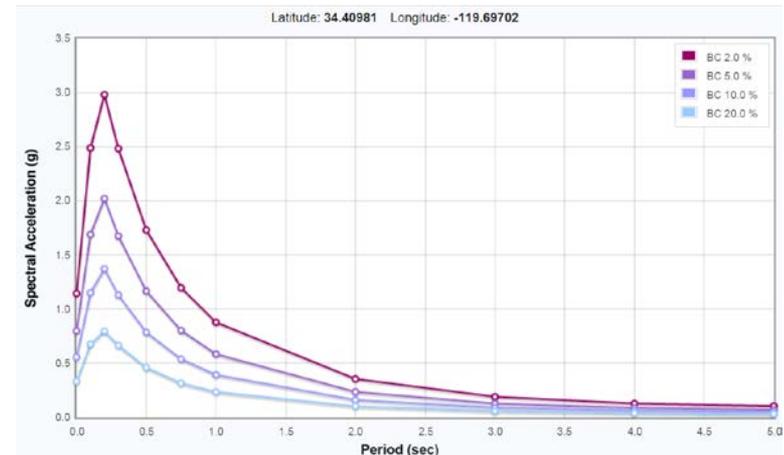
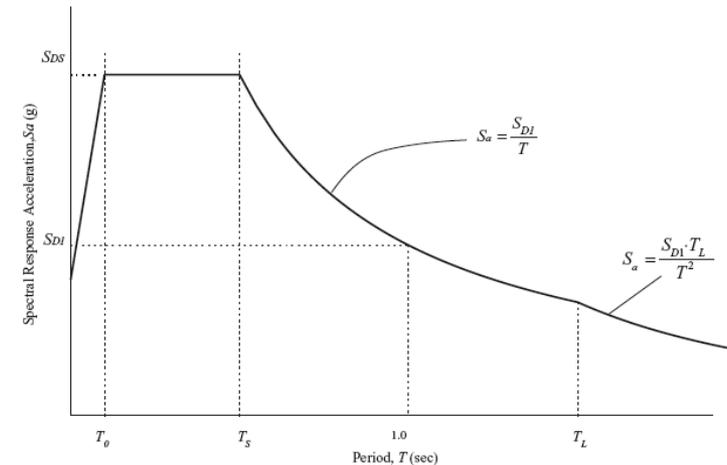


## 3. Precision & Uncertainty

- *Importance* – Apparent instability of design maps can lead to rejection of updates based on USGS NSHM.
- *Risks* – Discrepancies between design maps and site-specific values (from NSHM).
- *Resources* – Issue team of engineers (structural and geotechnical) and scientists, in-person meetings. Preparation of “samples”.
- *Schedule* – First ~1 year of Project ‘17.

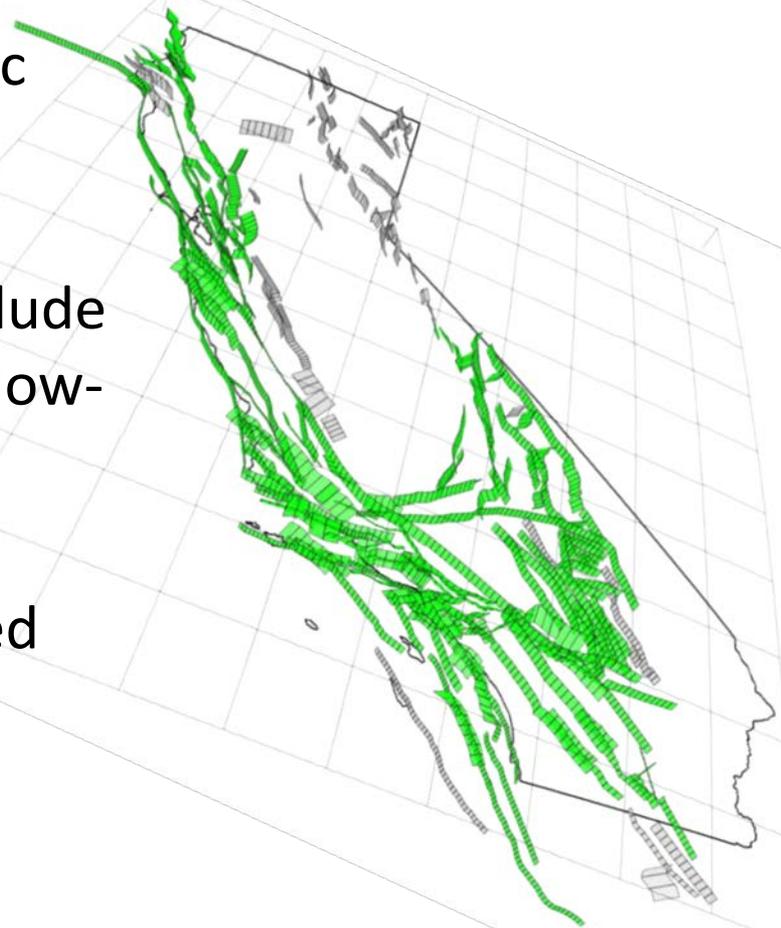
# 7. Multi-Period Spectra

- *ASCE 7-10 & 2015 NEHRP Provisions* use two-point design spectra, for  $v_{S30} = 760$  m/s
- USGS NSHM has provided results for many periods &  $v_{S30}$ 's
- Long-period results are sensitive to basin effects, & short-period results impact numerous design provisions



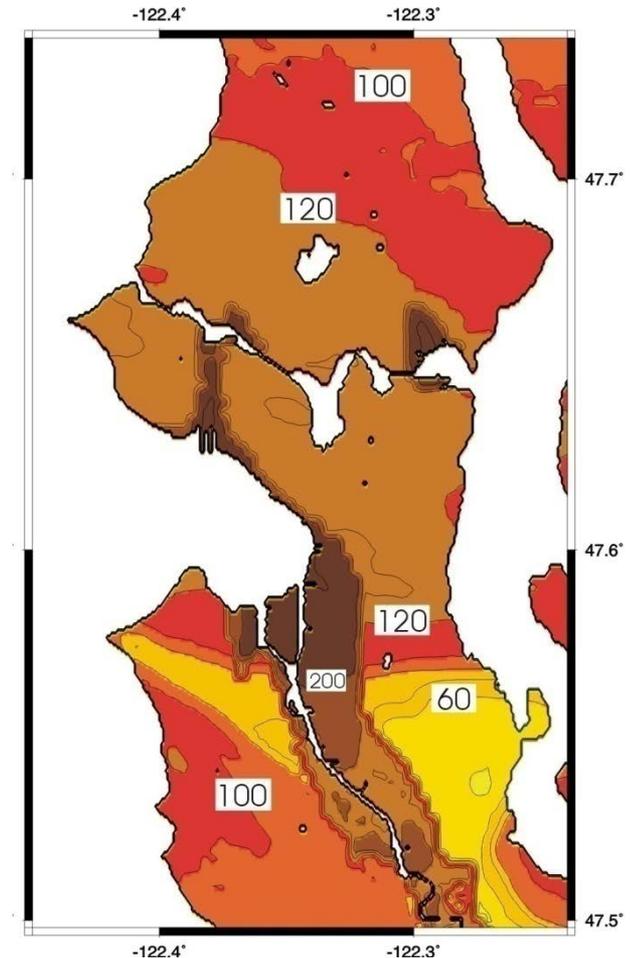
# 11. Deterministic Caps

- *ASCE 7-10* calls for “characteristic earthquakes on all known active faults”
- UCERF3 & 2014 USGS NSHM include multi-fault (M8+) ruptures, and low-slip-rate ( $\leq 0.1\text{mm/yr}$ ) faults
- For *2015 NEHRP Provisions*, *ASCE 7-10* definition was retained
- Project ‘17 could reassess how/whether deterministic caps are calculated



# 13. Use of 3-D Simulations

- USGS “urban” SHM for Seattle (Frankel, 2007) used by engineers but not incorporated into NSHM & design maps
- SCEC UGMS Committee (Crouse et al) exploring use of “CyberShake” SHM for Los Angeles design maps
- *Project ‘17 could also incorporate simulation-based SHM being developed by USGS for Salt Lake City*



# Next Steps

- *Next 2 weeks:* Webinars to solicit public comments.
- *Next month:* Prioritize issues.
- *Next few months:* Select issues and form issue teams.
- *Next calendar year:* Start work on selected issues.

# Current List of Issues

1. *Timing for updates*
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